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Manuscripts should be double spaced and should be submitted in duplicate, as part of the delay in referring is then avoided.

For more detailed information concerning the preparation and lay-out of scientific papers, authors are referred to the C.S.I.R.O. publication "Guide to Authors" and to an article entitled "The Preparation and Editing of Technical Papers" by N. S. Noble, published in the Australian Library Journal, April, 1954. The policy laid down in these publications is also largely followed by this Journal.

In addition to the contributions described above, the Journal is pleased to publish "Letters", "News Items", "Talks" and "Personal Notes" which have been received from, or which are of interest to, members of the Institute.

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ARTICLES

APPLE STORAGE IN AUSTRALIA

By R. N. ROBERTSON and D. MARTIN

It is often said that the cool storage of fruits, and particularly the storage of apples, decreases their quality. Many people suggest that we no longer get apples of such good quality as "when we were youngsters". These vague impressions are not consistent with the facts. There has been a reduction in the number of varieties grown so that some which were difficult to store or to market or which were unreliable in production are no longer available, but the net result of cool storage has been an increase in apples of good quality available throughout the year. Not only are apples available at times when, prior to cool storage, no apples could be bought but also the industry has been greatly stabilized by the spread of the marketing period.

The total production of apples in Australia is now approaching 12,000,000 bushels each year; in the ten years from 1946 to 1955 the average per season was 11,000,000 bushels. Of this total quantity approximately 4,000,000 bushels (4,600,000 in 1956) are exported each year, mostly to the United Kingdom, with Sweden, Germany and Malaya the next largest markets. The principal exporting States are Tasmania, which is responsible for about three-quarters of the apples exported, Western Australia and South Australia. The remaining fruit, about 8,000,000 bushels, is marketed in Australia. The value of production of apples, which has been rising steadily for some years was over £14,683,000 in 1953-54.

The export of apples and the storage of apples for the Australian market are distinct but related problems in fruit handling. Apples for export are usually not stored for any length of time prior to transport but are sent as soon as practicable after picking during the period from February to June. Cool storage during transport by ship is general but the period seldom exceeds seven weeks. The transport problems which were common during the early days of apple export were due to lack of knowledge of the right time to pick the fruit in the orchard and of the best conditions of refrigeration and ventilation in the ships' holds. These problems have now been completely overcome and it is exceptional for trouble to develop during a voyage to U.K. or Europe. Such troubles as may occur can be identified and usually the cause can be traced. Problems of apple export were surveyed by the late W. M. Carne, writing in this Journal in 1950. In this article we shall deal with the practice and problems of storage in Australia for the local market, which in contrast to the short storage during overseas transport, involves storage over months.

Cool Stores in Australia

It is only about 100 years since the first commercial refrigerator was invented by Mr. James Harrison, of Geelong. The first experimental consignment of refrigerated apples from Australia to England was sent in 1879. During the 'eighties, refrigerated shipments of apples went from Victoria and Tasmania, and in Victoria, small quantities of fruit began to be stored in city ice works for late marketing in Melbourne. The first commercial cool store for apples in Victoria was erected at Pakenham in 1900.

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Most of the early cool stores throughout Australia were large and were erected by Governments or Co-operatives. A distinct change, especially since the last war, has been the increase in the number of cool stores of smaller capacity owned by individual growers. These orchard cool stores vary in capacity but usually range from about 2,000 bushels to 10,000 bushels. In Victoria alone there are now about 150 orchard stores and most progressive growers have built or contemplate building their own stores.

Since cool storage began, our understanding of the requirements of the different varieties and of the best designs of stores has increased greatly. At first it was not realised that all varieties of apples cannot be stored at the same temperature and that for each variety the maturity at picking might be critical in determining its storage quality. The stores often gave poor performance if judged on temperature distribution and it was not uncommon for fruits near the cool air intake to be frozen while fruits in another part of the same chamber remained above their best temperature of storage. Since apples are living tissue and are killed by freezing, the temperature must not be too low but it must be low enough to reduce the metabolism of the fruits themselves.

Several designs of cool store have been found satisfactory if properly managed. Many stores—called the direct expansion type—were built with the expansion coils producing the refrigeration under the ceiling of the storage chamber. In other stores the expansion coils have been used to refrigerate a tank of brine which is circulated through the coils in the storage chambers. In others air cooled by the refrigeration system is circulated through ducts in the storage chambers. Until recently the smaller orchard stores were usually of the direct expansion type, but the use of small refrigeration units, containing freon or methyl chloride as the refrigerant, in each storage chamber has become popular. These units, placed near the ceiling, have a blower attached to circulate the air within the room. Satisfactory insulation has always been an expensive item in the construction of cool stores. Formerly the insulation usually consisted of 12 to 15 inches of buzzer chips between a double wall all around the chamber, including floor and ceiling, or of the more expensive cork slabs. A wider range of insulating materials is now available. Most of the orchard stores are constructed of timber with 5 or 6 inch studs and joists and the spaces between them filled with "Insulwool". Improvements in automatic controls make it possible for the small store operator to obtain good temperature control without constant attendance.

Apple Varieties and Temperature of Storage

Various disorders which made their appearance in the cool stored fruit were due entirely to the effect of low temperature on the physiology of the fruit tissues but it was not until the 'twenties that systematic investigations led to better definitions of storage conditions. All State Departments of Agriculture took some interest in the problem of storage but the first co-operative work was carried out by the joint authorities of C.S.I.R.O. and the Victorian Dept. of Agriculture on the mainland, and by C.S.I.R.O. and the Tasmanian Dept. of Agriculture in Tasmania. Most of the Tasmanian work was concerned with export problems, and the work on the mainland with long storage problems. Shortly before the last war, the Commonwealth Committee for the Co-ordination of Fruit and Vegetable Storage Research was established. This Committee which has a representative of each State Department of Agriculture, of the Divisions of Food Preservation and Transport and of Plant Industry, C.S.I.R.O., and of the Dept. of Primary Industry has met regularly since the war and provides an opportunity for defining storage problems and co-ordinating the research in the different districts

in which apples are stored. Recently the New Zealand D.S.I.R. has been represented on this Committee.

The theory behind cool storage is that lowering of the temperature results in a slowing down of the biochemical and physiological processes in the fruit; the lower the temperature the slower these processes. The freezing point of apple tissue is at about 29°F. and the temperature must never be allowed to go below that point in any part of the store. With the improved design in stores it is now possible to approach this temperature and in the storage of certain varieties 30°F. is the best temperature. Experiments have shown that for varieties Democrat, Yates, Crofton and Granny Smith, no low temperature disorders developed at 30°F. and this temperature is significantly better in prolonging storage life and preserving quality than 32°F. Other varieties however, cannot be stored at such low temperatures; Statesman, Stewart and Delicious can be stored at 32° without loss. Jonathan and King Cole will develop disorders known as soft scald and internal breakdown, when stored at 32° and must in consequence be stored at higher temperatures.

The Jonathan is a particularly interesting example of the results of research leading to satisfactory recommendations (Trout, Tindale and Huelin, 1940). When it was found that this variety would not stand the low temperature of 32°F. the recommended temperatures were about 36°F. but were accompanied by considerable decline in quality and sometimes considerable losses. Work in Victoria showed that a compromise could be effected by storing this variety at 36° until the end of April, 34° during May and 32° thereafter. Normally all stores now adopt this technique for Jonathans and have satisfactory conditions.

Fruit Size and Maturity

The most important factor in ensuring that fruit stored at the correct temperature for the variety does not develop storage disorders is picking at the right time—termed the correct maturity for storage. As an apple develops or matures on the tree, a number of changes take place. Cell division is complete within about four weeks of blossom and thereafter development is due entirely to the enlargement of cells and intercellular spaces. In addition to increase in size, other changes take place particularly as the fruit approaches maturity: the green or ground colour becomes lighter and brighter and eventually yellow, the red colour if present becomes brighter, the seeds change from white to brown, hardness, starch and acidity decrease and sugars increase. Measurement of each of these changes and of a number of other things which change less noticeably has been suggested as a method of determining the best maturity for picking fruit which is to be stored, but no really satisfactory criterion of maturity has emerged from any such measurement. Many of the observations were confused by total neglect of the fact that fruits are increasing in size while these maturity changes are taking place. The work of Carne and Martin (1938) showed that the size of the fruit may be the most important factor, particularly in controlling the development of bitter pit and low temperature breakdown in storage.

Apples from light crops are generally larger than those from heavy crops and Martin and Carne (1940) showed that the susceptibility to breakdown of fruit from a particular tree could be fairly closely predicted from the average size of the apples on that tree. The larger the fruit, the greater the liability to storage disorders which explained why fruit from trees in the "off" year did not keep as well as fruit from trees of the "on" year. It was also found that the larger fruits from a heavy crop were less susceptible to these disorders than the same sized fruits from a light crop. The work of Martin and Lewis (1952) using techniques established by Bain and Robertson (1951) showed that mean cell size might

be a critical factor in determining susceptibility in apples. Using a number of varieties, Martin and Lewis showed that the differences in fruit size between light crops and heavy crops were due mainly to mean cell volume. Within a variety, light and heavy crop fruits undergo much the same amount of cell division but cell enlargement in the subsequent period is greater in light crop fruits. Thus apples of the same weight from light and heavy crops differ in their mean cell volume and this difference is associated with their difference in susceptibility. It was also found that apples with higher cell volume give a higher rate of respiration per unit protein. This may be a useful lead for future work designed to explain the difference in susceptibility.

The value of this work is that it is now possible to predict the susceptibility of apples to these disorders by taking account of mean fruit size and crop size. Further it has opened the possibility that control of cell division (which is influenced by the same factors as decrease alternate cropping) may give fruits of good size with higher cell numbers, lower cell volumes and hence less susceptibility to these disorders.

Apple Scald

One of the commonest disorders in apples in Australia is the superficial browning of the skin called superficial scald. Only two or three layers of cells are affected (Bain 1956). This disorder which takes some time in cool storage to develop is worse at lower temperatures and in less mature fruits. It is particularly troublesome in the Granny Smith variety. It can be largely controlled by wrapping the apples in papers which have been impregnated with oil, but this treatment is expensive since all fruits must be wrapped before they are placed in the cool store for any length of time and the control of scald is not perfect. Other treatments have been tried, the most effective being a delay at higher temperatures before final storage at low temperatures (Melville and Hardisty 1953). The effectiveness of oil wraps has suggested that the wrap may absorb some volatile compound produced by the fruit itself which, if left at the surface, causes the death of cells. Some experiments have shown that very rapid ventilation of the fruit or circulation of rapidly moving air over fruit and through activated charcoal to remove volatiles may also decrease the scald. These treatments are impracticable on a commercial scale as the air movement necessary is considerably greater than can be achieved easily. While the circumstantial evidence suggests that scald is caused by a volatile compound and various compounds are known which will produce scald-like symptoms when in contact with the surface of the apple, the compound or compounds produced by the apple itself and responsible for the scald have not been identified.

Recently research has been directed towards the study of possible inhibitors of the scald. This work follows a valuable discovery by Professor R. M. Smock (1955) of Cornell University, that apples dipped in a solution of diphenylamine (about 1,000 p.p.m.) would not develop scald, while control, undipped fruits developed 100 per cent. scald. Professor Smock very kindly sent his observations to Australia before they were published and work on the use of diphenylamine was begun both by Martin (1956) in Tasmania and Hall (1957) in N.S.W. Results with dips confirmed those already obtained by Smock and the work was extended with diphenylamine impregnated paper wraps and pre-harvest sprays. The diphenylamine wraps gave complete control; the pre-harvest sprays were variable but gave sufficient promise to warrant further work. In the current apple season, thanks to the Committee for the Co-ordination of Fruit Storage Research, trials with standard wraps containing diphenylamine will be conducted in all states of the Commonwealth and in New Zealand. While diphenylamine has proved thoroughly

satisfactory on an experimental scale, no commercial recommendations can be made until the toxicological status of diphenylamine has been established. No thorough examination of its pharmacological effects is available and what information is in the literature is not easy to interpret definitely.

Gas Storage

While improvement in cool storage conditions has lengthened the life of apples and maintained their quality, a longer life and better quality can be obtained with gas storage. This technique depends on varying the oxygen and carbon dioxide in the cool chambers. The simplest technique is to allow the respiration of the fruit to reduce the oxygen and at the same time to build up the carbon dioxide concentration in chambers which have been made gas tight. Since this technique limits the amount by which the oxygen can be reduced without building up an undesirable concentration of CO_2, most gas stores are operated with a "scrubber" consisting of an alkaline solution through which the air is circulated to absorb excess CO_2. This system of gas storage is widely practised in England, and will increase the storage life of several varieties of apple by approximately half as much again as cool storage, i.e., if the cool storage life of the variety is four months, gas storage will increase it to six. While gas storage has been used for pears, especially for caning pears of the Williams variety, for many years in Australia, little commercial use has been made of this technique for apples until recently. Experiments both at Homebush by Hall (1956) and in Hobart by Martin (1956) have shown that several varieties of Australian apples are satisfactory under gas storage. In the variety Granny Smith, for instance, the undesirable yellowing has been delayed and the crisp texture with good flavour has been maintained until Christmas. It seems probable that gas storage of the better dessert varieties will lengthen their storage life and maintain their quality so that varieties like Democrat which have long storage life but poor quality may be eliminated.

Current research on gas storage is concentrating on two main problems:

(1) Storage at low oxygen concentrations accompanied by low carbon dioxide.

(2) The elimination of scald which is normally worse in gas storage. In the first of these problems attempts to keep the carbon dioxide as near to zero as possible have given improvement in storage of some varieties which were particularly susceptible to injuries increased by carbon dioxide. Our attitude to the second problem is likely to be greatly influenced by the possibility of diphenylamine in wraps as a method of scald control. If diphenylamine will eliminate the increased susceptibility to scald, the gas storage technique will become of great importance.

Quality in Stored Fruit

Now that disorders of storage are largely controlled or eliminated and fruit of good appearance can be stored for the whole period between the fresh fruit season, more attention should be paid to the improvement of quality in stored apples. Frequently because the appearance of stored fruit is so good, varieties like Jonathans are being marketed after the period when their quality judged by flavour and texture has declined. Since apples are bought on appearance rather than on a knowledge of eating quality there has been no marked consumer reaction to this tendency. It seems necessary therefore to carry out some more experiments to define the limits of cool storage and gas storage when judged by satisfactory eating quality.

Unfortunately, investigations of this type are handicapped by the absence of any objective test for quality. Information of this kind can be obtained only by properly conducted tasting tests which involve statistical analyses of the opinions of a panel of tasters. This tech-

nique is now standard practice in food research laboratories but has not yet been applied to defining the limits of storage life of apples.

Future Research

Apart from some adequate investigations of quality and of maintenance of quality in the stored fruit there is little further investigation which could improve storage techniques by empirical trials. It has become increasingly clear that further advances will arise only from a better understanding of the physiology of the fruit itself, particularly in relation to its growth and change in maturity. For this reason investigations of the growth curves of apples of several varieties are being carried out simultaneously in different parts of the Commonwealth. The conditions during development in a sub-tropical highland area like Stanthorpe, Queensland, are clearly different from conditions over the same period in the cool temperate regions of Tasmania. Harvest dates for best maturity for storage are likely to vary from season to season but we have not yet sufficient information on the physiology of the apples to be able to describe how they differ, let alone make recommendations as to how this could be judged by the practical man. Fortunately, in this field of fruit storage research the co-operation between the State Departments of Agriculture and the C.S.I.R.O. is excellent and the necessary work will be co-ordinated and carried out.

Acknowledgements

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DRY FARMING PATTERNS IN QUEENSLAND

By L. G. MILES

Significance of Dry Farming in Queensland

While the term dry-farming may be capable of more than one interpretation, it generally refers to methods of agriculture in relatively dry regions where some form of moisture conservation is required for normal crop production.

In most of the districts in Queensland to which this term is commonly applied, the average annual rainfall is not, by world standards, low. It is frequently the case in such districts that rainfall may be excessive for normal crop requirements during a particular season. However, four factors tend to operate to the effect that drought rather than excess is the most serious cause of loss in such districts; these factors are (i) the uneven distribution of the rainfall over the growing period of a crop, (ii) the tremendous variability in total rain per year or per season, (iii) high rainfall intensities resulting in considerable run-off, and (iv) the high evaporation and transpiration rates during the greater part of the year. A five or six months' summer season may often provide a high total rainfall, but at the same time include one or more heat-wave periods of sufficient severity to cause serious damage to crops.

The areas in Queensland to which these conditions mainly apply are those lying between the 20 in. and 30 in. isohyets in southern and central parts of the State. North of latitude 22½° there is virtually no crop culture within these isohyets, and, as the rainfall becomes more clearly seasonal (monsoonal) the further north one goes, the problems involved are somewhat different from those in the subtropics. The agricultural districts mainly involved in our dry-farming considerations are therefore the Darling Downs, the Maranoa, parts of the Burnett River basin, and the Fitzroy River basin (including the Callide and Dawson Valleys and the Central Highlands).

The present area cropped under dry-farming conditions is approximately two million acres out of a total area under crop of less than three million acres (based on 1954-55 statistics). However, the areas to which these principles of farming could eventually apply total well over ten million additional acres.

Rainfall and Soils

Average rainfall data for three of the districts under discussion are given in Table I.

TABLE I.

Mean rainfall (inches).

District	Total	May-Oct.	Nov.-Apr.	Per cent. Nov.-Apr.
Darling Downs	26.06	9.56	16.50	63.3
Callide-Dawson	27.25	8.94	18.31	67.2
Cent. Highlands	25.71	7.47	18.24	70.9

In this table the above divisions have been made because May-October corresponds approximately with the growing period of "winter" crops and November-April with that of "summer" crops.

The main soil types to which dry-farming practices apply are either heavy black clays initially under open grass cover, or clay loams which are either alluvial or sedentary. These soils have the capacity to store considerable quantities of water

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for the use of subsequently planted crops. The basaltic red loams, which are characteristic of a number of tableland areas, have not the same capacity for holding water, and are therefore used mainly for summer cropping during the period of maximum precipitation.

Fallowing Practice

The benefit of moisture conservation by means of bare fallowing first became evident in the Darling Downs and Maranoa districts of southern Queensland in relation to wheat growing. It has been known to farmers and agriculturists for many years that it is possible to obtain a useful yield of wheat during a growing season in which no effective rainfall is received after planting, provided, of course, that ample rain was conserved during the preceding wet season. In addition, it had been demonstrated in the Maranoa that an eighteen months' fallow gave a yield of 24 bushels per acre, and a six months' fallow a yield of 17 bushels per acre in a season in which only 2 inches fell during the growing season.

It thus became common practice on the Darling Downs to fallow the land each year during the period December to May or June, and to plant the wheat crop on the first suitable planting rain in the period from late May to early July. This practice normally assured a crop of wheat, provided, of course, that a suitable planting rain was received during the aforementioned period. In the occasional years in which a complete drought occurred in the middle of the year the wheat crop failed, not because of insufficiency of stored water, but through lack of a germinating rain. In such seasons it was customary to allow the land to continue fallow until the spring when a summer crop such as maize, sorghum, sunflowers or cowpeas, would be grown on the first good planting rain. So great was the success attendant on fallowing that many farmers preferred a winter grain crop to a summer grain crop although the rainfall expectancy for the season of the former was only half that for the latter. The reason for this attitude was of course that a "season in the ground" was regarded as a safer proposition than a "season in the air".

Water Storage Under Fallow

The storage of water in soils and the utilisation of this stored water by growing crops have been the subject of many years' study by Wells (1951) and his associates at the Biloela Regional Experiment Station. The alluvial clay loams on which much of this work was done have field capacities of approximately 26 to 28 per cent. and wilting points of 12 to 14 per cent. This means that in a soil commencing a season at field capacity, moisture representing about 14 per cent. of the dry weight was available for plant growth. This available moisture is equivalent to approximately 2 in. of rain per foot of soil. Thus in 4 feet of soil wet to field capacity, there would be approximately 8 in. of water available for crop use. Under conditions of most efficient utilisation in that environment, this water is capable of producing 35 to 40 bushels per acre of wheat.

Similar studies have been made on the Darling Downs in recent years by the Department of Agriculture and Stock at Hermitage Regional Experiment Station, and by Waring (unpublished data 1951, 1952 and 1953) of the Queensland University. In some of these heavy clay soils, Waring's figures indicate that field capacity may reach to 60 per cent. of the oven-dry weight of soil. The wilting point of such soils may exceed 40 per cent., but there remains in them a margin of 15 to 20 per cent. of moisture which is available for crop use. This margin is equivalent to 2 to 3 in. of water per foot of wet soil.

The Crop Factor in Dry Farming

Reference has been made to soil and climatic factors and their effects upon the dry farming pattern in Queensland, particularly that aspect relating to the popularity of winter crops in a climate of predominantly summer rainfall.

Another pertinent factor has been the crop factor. Wheats were bred for many years at the dry centre of Roma in the Maranoa district, and all the earlier varieties produced by Soutter in this environment showed a considerable degree of drought resistance compared with introductions from elsewhere in Australia. The effect of this breeding programme reached its peak in the 1940's when more than 80 per cent. of the State's wheat acreage was sown to locally bred varieties. With improvements in the technique of conserving moisture for wheat, coupled with increased knowledge of the effectiveness of a "season in the ground", emphasis has tended to shift from drought resistance to such other characters as innate yielding capacity and disease resistance.

Among the summer crops the main pattern was the change-over from maize to grain sorghum as the principal summer grain crop. The reasons were mainly twofold—the first being the proven capacity of sorghums to stand up better than maize to periods of drought stress, and the second, the facility with which dwarf grain sorghums could be harvested by standard wheat-harvesting machinery. Even with sorghum, however, the often-found tendency to treat the crop as a hardy one resulted in failures through drought stress. The fact that the crop was frequently grown by stock farmers meant that crop failures were seldom a total loss, because they provided useful grazing during a dry period. However, it soon became clear that even sorghum was by no means a reliable grain crop in seasons of low or badly distributed rainfall.

Fallowing for Summer Crops

The success of grain sorghum crops grown on the Darling Downs and in other districts following a wheat crop failure in 1946-47, first drew widespread attention to the benefits of a long fallow in ensuring the success of a summer crop. It is reiterated here that the cause of the wheat failure of 1946 was the lack of any general planting rain. Much of the water conserved for the wheat crop was still available for the use of the summer crop, and the conserved moisture tided the crop over the inevitable midsummer heat-wave periods without any serious check. Further evidence of the value of conserved moisture to a sorghum crop was obtained from varietal trial plantings on the Darling Downs in 1949-50. This was a season in which higher than average rain fell, but in which there also occurred a severe heat-wave during January. Yields of the four leading varieties on similar soils at two different sites are given in Table II.

TABLE II.

Sorghum Variety	Bongeen Long fallow* bus. per ac.	Brookstead Short fallow† bus. per ac.
Alpha	95.9	41.5
Martin	92.1	43.5
Kalo	89.6	44.4
Early Kalo	89.1	52.6
Mean	91.7	45.5

*Summer plus winter †Winter only

Wells (1951) has shown at Biloela that the water available to a sorghum crop up to the flowering period is all-important from the viewpoint of grain yield. It is immaterial whether this water is wholly held in the soil prior to planting or made up partly by post-planting additions. As, however, about 10 in. of available water during this critical period is sufficient for a satisfactory grain crop, the provision of 4 to 5 feet of wet soil (equivalent to 8 in. or more of available water) provides a splendid crop insurance.

The development of soil moisture conservation to include summer crops may involve long periods of bare (or nearly bare) fallow. In winter seasons of higher than average rainfall, it is possible to conserve several inches of available moisture for the benefit of the succeeding summer crop. In many other years, however,

the conservation during a six months' winter-spring fallow would be negligible, and it would be necessary to include a portion or whole of the ensuing summer within the fallow period if the desired depth of wet soil were to be obtained. It can thus be seen that where a succession of summer crops is to be grown *on adequate stored moisture,* fallow periods of eighteen months might often be required. Fortunately, the other climatic factors in the areas under discussion are such as to sustain the growth of both summer and winter crops. It is thus possible to switch from a summer crop (or series of summer crops) to a winter crop with the intervention of a twelve-month fallow period.

The process may be reversed at will by the use of another fallow period of similar length. The twelve-months' fallow period, if properly handled, should always enable the ensuing crop to commence its life with the greater part of its water requirements in hand. The crop farming of the most successful grain producers on the Darling Downs is now based upon an alternation of a small series of winter crops on short fallow with a smaller series of summer crops on short fallow and the intervention of a twelve-months' fallow between each change of phase.

Under such conditions, particularly on the more fertile soils, maize could be grown with far greater certainly than in years gone by, and some excellent yields would be obtainable. However, sorghum is still preferred as the main summer grain crop under dry-farming conditions, chiefly because of (i) the greater ease of mechanical harvesting, (ii) the better feed values of the crop residues, and (iii) the suitability of the crop to close row spacing which can eliminate the necessity for inter-row cultivation.

Implements in Relation to Dry Farming

Both soil and crop factors in the dry-farming pattern have been briefly discussed, but no mention has yet been made of the place of agricultural implements in this pattern. Briefly the development of effective moisture conservation measures on the heavy black soils of the Darling Downs (which are frequently self-mulching) was associated with (i) the burning of crop stubbles, and (ii) the shallow working of the fallows with tined implements (chiefly scarifier and combine drill). Ploughs were seldom used except to bring grassland under cultivation initially; disc cultivator-ploughs of the "sundercut" type were mainly used where weed growth in fallows became too heavy for tined implements to cope with. In other districts, particularly on soils of poorer structure, ploughing was normally the first operation after harvest, the object being to leave the land in rough condition during the anticipated period of heavy rain. This was followed by disc and tine cultivation as required until seeding time.

These methods of management proved highly successful in trapping moisture, but in sloping country exposed the surface soil to serious erosion losses. This has been particularly true of the eastern section of the Darling Downs, and other similar black soil areas of undulating topography. The extensive "prairies" of the central and north-western Darling Downs district have been relatively free from such troubles by virtue of the flatness of the country, but even here water disposal problems have become more serious with the transition from grassland to arable land.

Soil Conservation

A general realisation of the gravity of the position has already resulted in a number of the following measures:—(i) protection of sloping country by means of such physical structures as diversion banks, contour banks and grassed waterways; (ii) the fallowing of erodible lands during the period of least intensive rainfall, requiring a definite swing towards summer cropping and away from winter cropping; (iii) the retention of stubbles to protect the surface of the soil from

direct raindrop action during torrential rain; (iv) the greater use of sown pastures in rotation with cultivated crops.

Some of these practices, for example, stubble conservation, are now being adopted by a number of farmers in spite of the difficulties involved. In stubble conservation the main problem is to devise suitable means of cultivation which will not unduly disturb the stubble mulch, but will enable weeds to be controlled. A further problem is that the more effective a stubble cover has been in protecting the soil from wash, the greater the obstacle it will offer to planting when the next crop season begins. The former problem is gradually being overcome by the use of newer machinery and the modification of some of the established types; the so-called "chisel-ploughs" probably offer the best prospects to date of adequately solving this problem. Various methods are also being devised for minimising the second difficulty, for example, the use of one-way disc cultivators during the latter portion of the fallow period, the use of disc drills in place of the now-standard tine drills, and possibly the surface use of nitrogenous fertilizers during the late fallow period.

It is strongly felt, however, that the most fundamental problem of all throughout the bulk of the area under consideration is that of the cheap and reliable establishment of effective pasture leys. Rhodes grass has already proved itself a most useful grass throughout much of the brigalow and soft-wood scrub areas, though in the past no fully satisfactory legume association was discovered. In recent years some real progress has been made in the utilisation of lucerne as a legume complement to Rhodes and green panic grasses, and phasey bean may also play an important part when problems of seed harvesting are overcome. Row pastures, including row lucerne, will probably have an effect in extending animal production over longer periods of the year, but will not fully take the place of sward pastures in restoring soil structure under a ley-farming system.

In many of the heavy black clay soils, pasture establishment is very difficult because of the self-mulching nature of the soils. The natural occurrence of a loose crumbly mulch of two to three inches depth over a compact moist sub-surface layer provides excellent conditions for the germination of relatively large seeds. Small seeds, such as most pasture seeds, cannot be placed at the same depth as the crop seeds, and are much more difficult to establish. This problem must be satisfactorily solved before any long-term stable agriculture can be devised for large areas of Downs country.

Fallowing and the Nitrogen Cycle

In this brief review, no reference has been made to crop requirements other than water. The reason for this is of course that water is the limiting factor to successful crop production in these areas. The soils in most general use range from moderate to high fertility, and, with certain exceptions, do not give responses in yield to standard fertilizer applications under existing conditions of land usage. These soils do nitrify readily under favourable conditions of moisture and temperature, and fluctuations in nitrate nitrogen content are very marked, according to whether the land is under grass cover, under row crop, or in bare fallow. Both Wells (in the Callide Valley) and Waring (on the Darling Downs) have demonstrated a marked build-up of nitrate nitrogen under bare fallow conditions.

Waring showed on one Darling Downs farm that whereas 102 lb of available nitrogen per acre was present in the top 4 feet of soil after six months' fallow, more than double this quantity was developed under an eighteen months' fallow. The nitrogen cycle in these soils is of extreme importance to their crop production, having important repercussions on both yield and quality of all crops sown.

However, while nitrate production has been studied in some detail in relation to weather, cropping cycles and crop responses, little is known of the changes in total nitrogen under the agricultural systems at present in use. While the variations in nitrate nitrogen are those which will determine the immediate crop responses each season, it is the trends in total nitrogen content which will determine the life of the soils under the existing cropping plan. Nitrogen losses due to cropping can readily be determined, but virtually nothing is known of the increments which may occur (through symbiotic or non-symbiotic fixation, or other possible causes) or of the balance between output and input. Fundamental studies of the complete nitrogen cycle will be essential to a full understanding of these soils and their long-term agriculture.

Summary and Conclusions

(1) It has been amply demonstrated within the 20 to 30 in. rainfall belt of south and central Queensland that the reliability of crop production can be greatly increased by moisture conservation in suitable clay soils.

(2) In most years, the State's winter-spring crops are dependent more upon stored moisture than upon rain falling during growth.

(3) Even with summer crops, which are grown during the period of highest rainfall expectancy, the value of a "season in the ground" has been repeatedly demonstrated.

(4) Since satisfactory moisture trapping normally requires a period of some months of weed-free fallow, the principle can only be safely applied to relatively flat land or land which has been adequately protected from loss by erosion.

(5) Wherever possible, stubble conservation should be adopted during fallow periods, and further research is required into methods of handling heavy stubbles during such periods.

(6) While moisture conservation demands the exposure of soil during periods of considerable rainfall, the principles of soil conservation demand equally that the soil should be protected during such periods. Even on flat country, where actual soil movement may be regarded as negligible, the system is exploitive and must eventually result in deterioration of soil structure. Such deterioration may be very slow on the heavier plains soils of the central and north-western Darling Downs, but it is clearly quite rapid in some of the "brigalow" and other soil groups. For the great majority of these soils, therefore, if not for all, a recurring pasture phase will be an absolute necessity if the present dry-farming pattern is to fit into a stable and lasting Queensland agriculture.

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SOIL FEATURES IN ARID REGIONS WITH PARTICULAR REFERENCE TO AUSTRALIA

By E. A. JACKSON

Introduction

In both Australian and overseas soil literature there are frequent references to "desert" or "arid" soils with the implication that such soils have certain characteristics in common. A review of the literature, however, reveals little unanimity of opinion regarding the nature of these characteristics and an examination of the available data makes it clear that few, if any, soil features are of sufficient universality for them to be spoken of as characteristic of arid soils. This paper will therefore deal with soils of arid regions rather than with "desert" or "arid" soils.

There are obviously different degrees of aridity and there is little agreement on the climatic limits of what may be regarded as arid environments. The term, arid, is used here to denote areas of low precipitation usually combined with high potential evaporation. The Australian arid region is regarded as being bounded by the 10 inch rainfall isohyet in the south, the 15 inch isohyet in the east and north, and by the Indian Ocean in the west. These limits are supported by a map prepared by Meigs (1953).

This paper describes some soil features in the arid regions of the earth in the hope that a broader view of Australia's arid zone may thus be obtained, and a background provided against which the nature of the Australian soils may be assessed.

Some Soil Features in Arid Regions

(a) General Soil Morphology

Early ideas on the general profile forms which could be expected in arid regions were based very largely on theoretical considerations. It was argued that, owing to low precipitation and absence of dense plant cover, chemical and biological weathering were insignificant and that the weathering process was almost wholly physical (Glinka 1927; Joffe 1936). It was therefore natural to suppose that the weathering process would not produce large amounts of clay; this, combined with the apparently low leaching potential of the environment, would result in the formation of soils with undifferential texture profiles. This concept has been expressed by Hilgard (1906, p. 163) as follows: "The formation of colloidal clay is very much diminished, so that most soils formed under arid conditions are of a sandy or pulverulent type. There is then little or no clay to be washed down into the subsoil, hence there is no compacting of the latter."

Schantz and Marbut (1923) were equally explicit when they stated that one of the most fundamental characteristics of desert soils was, "the absence of any zone of illuvial accumulation in the soil section, or, in other words, the absence of a subsurface horizon heavier than the soil except in those cases where this is due to geological conditions."

In Australia, Prescott (1931) lent support to this idea by publishing a diagram which implied that soils of arid regions could be expected to have no horizon of clay illuviation. He suggested also that the nature of the soil profile in arid regions was of minor importance. He stated: "In the true deserts the profile becomes of little importance and the various soil types, if they can be so called, have received definite recognition in scientific nomenclature". He then refers to

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such terms as Barkhan, Serir, Hamada, and Erg.

Lapham (1932) was one of the first to actively challenge this widely accepted view respecting the nature of soils in the arid zone. He described soils from the arid regions of the U.S.A. which had well developed clay subsoils and he claimed that the old view was completely erroneous. Later, Nikiforoff (1937) stated that the formation of claypans was, "one of the principal zonal characteristics of the Desert type of soil formation". His view was thus diametrically opposed to that of the earlier writers. He attributed the formation of claypans to the hydrolytic decomposition of clay-forming minerals *in situ*, such weathering being facilitated by the percolating water which, although evaporated quickly from the surface horizons, was retained in the subsoil long enough to promote hydrolysis.

Ravikovitch (1953), Muir (1951), and Reifenberg (1952) have described soils from Palestine and Syria which do not appear to have well developed texture profiles. Kellogg (1953) in discussing the features of desert soils states that:

(i) Old arid soils normally have some concentration of clay in their B horizons.

(ii) Clay contents are generally lower than in other soils.

(iii) Every conceivable combination of texture profile may be encountered.

Most of the early discussions of Australia's arid-zone soils appear to have been based on very meagre field data, and were probably influenced to some extent by the ideas then current overseas. Two soil maps of Australia were produced (Prescott 1930, 1944) but neither were accompanied by descriptions of soil profiles. Teakle (1936, 1937) described soils from the arid portion of Western Australia. Prescott and Skewes (1938) presented analytical data and a small amount of field information on a miscellaneous collection of soils from the arid regions. Skerman (1947) published a map, together with field and laboratory data, on the soils of the "channel country" associated with the braided stream channels leading to Lake Eyre. Beadle (1947) has presented field and laboratory data on soils in the arid portions of New South Wales, while several other plant ecologists have contributed soils data of a rather fragmentary nature.

Jessup (1951) conducted a soil survey of a large area in South Australia and this embraced portion of the driest region in Australia; his paper represents the first adequate report from arid Australia of soil morphology and chemical constitution based on the survey and mapping of the soils. The data thus presented show clearly that large amounts of clay are by no means uncommon in the arid areas and that every conceivable form of texture profile is encountered; the soils may be sandy throughout, clayey throughout or have sandy surfaces either abruptly or diffusely separated from clay subsoils. This statement is further supported by the work of other writers mentioned above and by Jackson (in press).

The early concept of texturally undifferentiated soils with low clay contents has therefore been completely discredited and it is now known that a great variety of texture profile forms are found in arid areas.

The most widespread structural feature of arid zone soils is the platy surface crust. This crust which may or may not be associated with a desert pavement has been observed on the soils of arid regions throughout the world (e.g., Nikiforoff 1937; Van der Merwe 1940; Muir 1951; Jessup 1951). In Australia it consists typically of brittle material sealed on the surface and vesicular below. Usually no more than $\frac{1}{4}$ inch thick it is easily separated from the underlying soil. It is frequently finely cracked when dry and the desert pavement, when present, is embedded in it. Loose sand grains are moved across this surface crust by the wind; it forms a most inhospitable seed

bed and is clearly of great significance to plant life and water penetration. The reasons for the development of this crust in arid regions do not appear to have been investigated but the shattering effect of rain on soil surfaces unprotected by plant material seems to be at least a contributing factor.

Kellogg's (1953) claim that clay subsoils in arid regions have blocky or prismatic structures is not wholly valid for Australia where many fine textured subsoils are friable and without noticeable structure (e.g., Jackson 1957 and in press). Other soils, it is true, do exhibit blocky, prismatic and columnar structures. Lapham (1932) has described "typical solonetz structure" in subsoils from the arid portions of U.S.A. Nikiforoff (1937), however, maintained that solenetz soils do not occur in arid regions. He contended that, in desert areas, soils which have profiles resembling the solenetz had nothing in common either genetically or chemically with the "true solonetz". If a high proportion of exchangeable sodium is regarded as the essential feature of the solonetz, Nikiforoff's claim cannot be made for Australian examples; soils with solonetz morphology from Australia's arid areas have been found to contain over 20 per cent. sodium in the exchange complex (Jackson, unpublished data).

Stephens (1950) discussed the colour of soils in arid areas and pointed out that the "red" desert soils of the U.S.A. lie on the 5YR and 7.5YR charts of the Munsell colour system compared with 2.5YR and 10R for Australian soils. Jessup's (1951) soil descriptions support this general statement respecting Australian soils. Brown colours lying on the 5YR chart are dominant, however, in the extreme southern portion (Jackson, in press). The Australian soils are therefore brown to red in the main while the 'red" desert soils of the U.S.A. give a general impression of pastel shades (Stephens 1950). Muir (1951) has given 7.5YR Munsell Indices for soils examined by him in arid regions of Syria.

The cold deserts of the world are characterized by grey soils. Joffe (1936), for example, quotes Glinka as giving the mean annual temperature for an area of grey desert soils in Turkestan as 50°F. Similarly at Twin Falls, a centre of grey desert soils in U.S.A., the mean temperature is 48°F. compared with 69°F. at Phoenix in the red desert soil region (Lapham 1932). In Australia the mean temperature of the arid zone varies from about 64°F. on the southern fringe to 82°F. at Marble Bar in the north-west. It is therefore a "hot desert" throughout and greyish soils are rare. This correlation between red soils and hot arid environments is a clear indication that the colours are the result of contemporary conditions. Reifenberg's (1938) claim that they are a legacy from red-coloured parent materials cannot be regarded as having general application.

The red colours are generally regarded as being caused by free iron oxides. Robinson (1949, p. 259) has pointed out that due to the low specific surface of sandy soils even small amounts of hydrated ferric oxide confer a marked red or brown colour. Gautier (1935) has observed that although the young dunes of the Sahara are white, the old ones are red. He suggests that the grains of the white dunes have not been exposed to the environment for a long enough period for them to be oxidised and reddened.

(b) Desert Crusts and Hardpans

Glinka's (1927) account of the "true desert" soils is almost wholly concerned with what he termed "desert crusts". These, he maintained, were the hallmark of a desert environment. Nikiforoff (1937) regarded the "hardpans" in soils of arid areas in U.S.A. as synonymous with desert crusts and an expression of the dominant soil forming process in arid regions. The desert crusts referred to by these and other writers may be in the

form of a coating or impregnation of the exposed rock, a subsoil horizon, or a substratum to an overlying soil. Their characteristic feature is an indurated rock-like consistency caused by a cementing substance which may be siliceous, calcerous or gypseous. They have been reported in the arid regions of the U.S.A. (Nikiforoff 1937), South Africa (Van der Merwe 1940), Chile (Storie and Mathews 1946), and Palestine (Reifenberg 1938). In Australia they have been described by Teakle (1936, 1937), Whitehouse (1940), Jessup (1951), and many others.

Perhaps the best known desert crust in Australia is the siliceous capping on the rocks of the interior. Many lithological types have been affected and the indurated product is commonly referred to as "grey billy", or, when disintegrated into stones and boulders, as "billy gibbers". In some areas a bleached shale has been impregnated with silica to form a porcellanite. The "grey billy" or silcrete frequently forms a massive capping to the mesas and cuestas of the interior, while the boulders resulting from its disintegration form the desert pavement of many of Australia's stony deserts.

Teakle (1936) and Stephens (1956) have described what are apparently siliceous hardpans from Western Australia, and the writer has observed identical features extending into the arid portions of South Australia. These hardpans which form a subsurface soil horizon are distinctly laminar and virtually impossible to penetrate with normal soil-sampling implements. They are sometimes impregnated with lime in addition to silica and, according to Teakle, are from a few feet to over a hundred feet thick. In Western Australia the overlying soil is acid. These hardpans have a different appearance from the massive surface silcrete of the interior, and Stephens (1956) suggests that their genesis is probably different also. However, both phenomena appear to be the result of siliceous impregnation and will be considered together as different forms of siliceous desert crusts.

Overseas writers (e.g., Glinka 1927; Joffe 1936; Nikiforoff 1937; Van der Merwe 1940) have attempted to explain the genesis of siliceous and other desert crusts on the basis of an upward capillary movement of solutions. This theory has continued to be advanced in spite of frequent demonstrations (beginning with Keen 1927) that soil capillary movements are significant only within a few feet of a watertable. It could be claimed (although it has not been) that the watertables responsible for the crusts are now no longer present or are much deeper seated. The theory that siliceous crusts are originally associated with watertables gains some support from the fact that the writer has observed what are apparently silica crusts in the process of formation in the beds of shallow salt lakes in Australia. These have also been noted by Baker (C.S.I.R.O. Division of Soils, unpublished report).

Nikiforoff (1941) has described siliceous hardpans from a semi-arid region in California; these appear to be very similar to those described by Teakle (1936). He explains the formation of these hardpans on the basis of a hydrolytic decomposition of minerals in place to yield siliceous and iron oxide cementing agents. He suggests, however, that the hardpans of desert areas are formed by a different mechanism.

Jack (1915) maintained that siliceous capping to the rocks in arid areas of Australia could be explained by the intense heating of rocks in summer; this facilitated the solution by surface waters of considerable quantities of silica which were subsequently deposited as a cement following the evaporation of the solvent.

Teakle (1936) regarded the siliceous hardpans in Western Australia as illuvial horizons. He suggested that the occasional heavy rains in the area were sufficient to cause sporadic severe leaching.

Madigan (1938) claimed that the siliceous capping represented evidence of a

former wetter climate. This theme was developed by Whitehouse (1940) who regarded them as relict horizons of a laterite profile formed during a pluvial Pliocene. Following the publication of this paper Australian pedologists virtually abandoned attempts to explain many arid-zone soil features on the basis of the existing environment. Teakle (1950), for example, rejected his earlier theory on the formation of hardpans in Western Australia and suggested that they were relict horizons upon which the present soils were forming. Jessup (1951) has invoked climatic changes in and since the Pliocene in an attempt to explain siliceous rock cappings and other features in arid South Australia.

The theory promulgated by Whitehouse and widely accepted in Australia ignores the fact that siliceous crusts are characteristic of present day arid environments, not only in Australia, but throughout the world, and that they are absent, or at least not common, in humid areas. They are evidently a product of arid environments and a true understanding of their genesis must surely be based on this fact.

On the southern fringe of the Australian arid zone and in the contiguous semi-arid belt, a calcareous crust is very widespread. This is popularly known as "travertine" in Australia and is a common feature in the zone of Brown Solonized (Mallee) soils (Prescott 1931, 1944). It is also common in the arid Nullabor Plain of southern Australia (Teakle 1937; Prescott 1944). It is not a widespread feature of Australia's inland arid areas but is clearly a form of desert crust as understood by overseas writers from Glinka onwards.

The occurrence of this crust on the outskirts of the desert appears to be paralled in South Africa. Respecting the arid areas south of the Kalahari Desert, Van der Merwe (1940) states: "Wherever the solid geological strata are covered by a thin layer of windblown material in the higher rainfall area, i.e., on the outskirts of the desert region, the desert crust is well developed and consists almost entirely of calcium carbonate". He then observes that in drier areas the crust seems to be cemented by silica and "alkaline compounds". In the Mediterranean region Glinka (1927) has pointed out that lime crusts are found in the winter rain belt but not to the south in the true desert region. Muir (1951) did not record lime crusts from the Syrian desert but according to Joffe (1936, p. 151) Blackenhorn observed them on the desert fringe.

Similar crusts, referred to in America as "caliche", have been recorded from arid and semi-arid portions of the U.S.A. (e.g., Youngs *et al.* 1931; Harper and Smith 1932). Storie and Mathews (1946) recorded a "caliche-like" layer in a soil in an extremely arid portion of northern Chile.

These lime crusts are therefore very common in arid areas generally, although in Australia and possibly some other countries, they are more typical of the desert fringe rather than the true desert.

Overseas writers have ascribed the formation of lime crusts to the upward movement of solutions by capillarity. Van der Merwe (1940), for example, in discussing the origin of the limestone in the soils fringing the Kalahari Desert, states that it is derived from the underlying rocks (gneiss, granite, sandstone, dolomite, tillite, etc.) and brought up in solution by capillarity. Where the sand is more than 15 feet thick insufficient water percolates to the underlying rocks to promote solution and capillary rise. Under these circumstances an incipient lime horizon is formed but no true lime crust. Similarly where the sand cover is insufficiently deep to prevent evaporation of the percolating water the carbonate horizon is not formed. The "well developed normal soils" thus consist of reddish sand varying in thickness from a few inches to 8 feet. This overlies limestone which, becoming less compact with depth, merges into the disintegrated bedrock.

Similar theories advanced to explain lime crusts in Australia were criticized

by Crocker (1946) who pointed out that soil capillary movements were limited to the immediate vicinity of a watertable. Crocker suggested that the carbonate in southern Australia was aeolian material derived from the continental shelf during the Pleistocene glacial periods.

It may be shown ultimately that the lime crusts in various parts of the world have had quite different origins, but their wide occurrence in arid regions and on desert fringes is certainly suggestive of a similar genetic history probably correlated with climatic factors.

Gypsum crusts have been recorded less frequently than other crusts. Nikiforoff (1937) stated that they were found in the U.S.A., and Glinka has reported their occurrence in Egypt. He also claimed that they were a feature of arid Australia. This claim apparently stems from Streich (1893), who, describing the country in the arid northern region of South Australia, stated: "The sands and loams overlie gypsum bands and indurated gypsiferous clays, which, when rising above the level of the plain, appear as flat-topped ridges". Gypsum is certainly very prevalent in the area described by Streich and in places deposits of it are somewhat hardened at the surface. In general, however, gypsum crusts are not a common feature of the Australian arid zone.

(c) Desert Pavement

A good description of desert pavement has been given by Marbut (1935): "This consists of a layer of gravel and small stones, lying practically bare and kept bare of fine material by the wind, which usually forms a rather firm crust capable of bearing some weight, but in most places it is not sufficiently strong to bear the weight of a man. In walking over it the crust breaks and the gravels forming it sink half an inch or more, making a well defined track in the pavement". These so-called desert pavements have been reported from most arid regions of the earth; the individual stones or boulders are commonly coated with "desert varnish"—also called "desert patina", "desert lac" and "desert tan". The commonly accepted explanation of the desert varnish is that it consists of the oxides of iron and manganese brought to the rock surface by water and there deposited following the evaporation of the solution.

The desert pavement has been universally regarded as a deflation effect, the residue remaining after the finer particles have been removed by the wind. If this is so it is reasonable to suppose that the original material, and probably the soil underlying the pavement, would be a mixture of stones and fine material. This is, in fact, the accepted view and is stated explicitly in the U.S.D.A. Yearbook (1938) "Soils and Men": "It will form only in places where the soil is composed of a mixture of fine grained and coarse grained material . . . it develops readily where soils are derived from conglomerates or interstratified gravels, sands, silts, and clays of alluvial fans".

Desert pavements described from many parts of the world appear to be consistent with this hypothesis. In South Africa, for example, Van der Merwe (1940) describes desert pavements derived from tillite from which the fine grained matrix is removed to leave the coarse material as a desert pavement. Similarly Ravikovitch (1953) describes soils in Palestine which have a pavement of stones and which are gravelly and pebbly throughout their profiles. A desert pavement described by Storie and Mathews (1946) in Chile is also underlain by gravelly soil material.

Many of the desert pavements of the Australian stony deserts, together with the soil underlying them cannot readily be explained on this basis. Jessup (1951) has given profile descriptions of the soils in the stony desert west of Lake Eyre. Jackson (in press) has described similar soils from the southern fringe of the same general area. Here the desert pavement consists either of pieces of the siliceous ("billy") crust or of quartzite, and it overlies a great thickness of virtually stone-free clay. These soils, called "stony

tableland soils" by Jessup, do not appear to be parallelled anywhere else in the world. In some areas the pavement undoubtedly represents the disintegrated siliceous crust and appears to have remained *in situ* during the weathering into soil of the underlying softer rock. In other places the pavement is essentially a quarzite similar to the country rock underlying the clay soils.

The origin of these soils, and particularly the origin of their desert pavement, presents one of the most puzzling pedological problems in Australia's arid zone.

(d) Soil Reaction

Most available data on overseas arid-zone soils indicate alkaline reactions. The values given by Van der Merwe (1940) for South African soils mainly exceed pH 8. The aeolian soils of Palestine range from pH 7.8 to 8.2 with occasional values as high as 8.6 (Ravikovitch 1953). Reifenberg (1952) reported that the arid zone soils of Syria have pH values of 7.3 to 7.6. The soils examined by Brown and Drosdoff (1940) in the Mojave Desert U.S.A. had mildly alkaline surface reactions. Kellogg (1953) in discussing the general features of the soils in arid areas stated that pH values are rarely lower than 7 and often alkaline.

However, Lapham (1932) claimed that the surface horizons of solonetz soils in the arid regions of the U.S.A. were slightly acid. Commenting on these results, Joffe (1936, p. 161) maintained that acid reactions were a typical feature of the surface horizons of "normal" desert soils. He suggested that a misconception existed respecting the alkalinity of desert soils and that this was probably due to the prevalence in arid regions of "alkali soils" as distinct from "normal soils".

In Australia a paper by Prescott (1927) indicated that soils became more alkaline with increasing aridity. As more data became available this thesis was modified and a distinction was drawn between "normal" (alkaline) and "special" (acid) soils. The latter were regarded as being relicts from a former wetter climate (Prescott 1931). "Special" soils in this sense included the "desert sand plains" in the Northern Territory and Western Australia, and the "brown soils of light texture" in New South Wales, Queensland and Western Australia (Prescott 1944).

As more data is collected it is becoming clear that a large proportion, if not the majority, of Australia's arid-zone soils are neutral to acid rather than alkaline. The earlier concept of alkalinity was based very largely on samples taken from the southern fringe of the arid region. The soils here are often strongly alkaline as shown by Jessup (1951) and Jackson (in press). North of 30° south latitude, however, acid and neutral soils appear to be more common. Table I shows the pH values of soils sampled during reconnaissance traverses in northern South Australia and the Northern Territory. The soils represented include the "stony deserts" and "desert loams" of Prescott (1944), and, in addition, young alluvial soils in the Macdonnell Ranges.

Published data on the reaction of the soils of the interior also fail to support the alkalinity concept. Skerman's (1947) figures for the soils of the "channel country" in Queensland (mean rainfall 8 inches) show that surface values range from 6.1 to 7.5. Beadle (1947) has presented a large number of pH values for soils in the arid portion of New South Wales. His determinations were made on soil pastes and the values are therefore lower than would be obtained by the 1:5 soil-water suspensions more generally used in Australia. Table II has been derived from Beadle's data.

Data presented by Prescott and Skewes (1938) show that the most consistently alkaline soils are found on the southern fringe of the arid region. Samples from the Warburton and Musgrave Ranges are neutral to alkaline while most of the remaining surface soils from the interior are neutral to acid.

TABLE I.

Reaction of surface soils in northern South Australia and the Northern Territory.

Location	Latitude (Approx.)	Mean Annual Rainfall (Approx.) (inches)	Depth (inches)	pH
Mt. Eba Station	30° 10′	6	0-½	7.2
,, ,, ,, ...	,,	,,	½-2	7.5
East of Coober Pedy	29°	5	0-½	7.0
,, ,, ,, ,, ...	,,	,,	½-6	6.3
West of Oodnadatta	27° 40′	5	0-2	6.7
,, ,, ,, ...	,,	,,	2-6	6.2
N.W. of Oodnadatta	27°	5	0-3	6.7
Henbury Station	25°	8	0-6	7.2
Jay Creek	23° 30′	10	0-12	7.1
N.W. of Alice Springs	23°	10	0-1½	6.9
,, ,, ,, ...	,,	,,	1½-9	6.5

The limited data available thus indicate that surface soils of the arid interior are more commonly acid to neutral rather than alkaline. Considering the arid region as a whole there is certainly no justification for believing that alkalinity increases with aridity.

(e) Calcium Carbonate

Some aspects of this subject have already been considered in the discussion of calcareous desert crusts. It was suggested that large quantities of carbonate were characteristic of the desert margins rather than the actual deserts. Neverthe-

TABLE II.

Distribution of pH values of surface soils in arid New South Wales (derived from Beadle 1947).

Range of pH	Tablelands and Ranges	Grey and Brown Soils of Heavy Texture	Brown Soils of Light Texture	Desert Loams	Stony Deserts
4-5	6	—	—	—	—
5.1-6.0	3	5	3	2	—
6.1-7.0	3	10	1	—	—
7.1-8.0	1	7	—	—	1
Number of Samples	13	22	4	2	1

less many soils in arid areas do contain large quantities of lime. In the Syrian desert, for example, the soils are derived from Tertiary limestones and are universally calcareous (Muir 1951). The aeolian soils of Palestine are likewise calcareous, the lime content decreasing with increasing aridity (Ravikovitch 1953). The arid-zone soils of Cape Province, South Africa, are generally calcareous (Van der Merwe 1940) but the Kalahari sand which covers the major part of the Kalahari Desert is apparently lime-free or almost so. The soils on the margin of this desert have a typical lime crust.

Wolfanger (1930), Lapham (1932), Marbut (1935), and the U.S.D.A. Yearbook (1938) "Soils and Men", all state that the arid-zone soils of the U.S.A. are calcareous. Youngs *et al.* (1931) observed that the older upland soils in Arizona had definite lime horizons which were lacking in soils formed on more recently deposited material. Nikiforoff (1937) stated that a zone of lime accumulation could not in general be regarded as a "Zonal characteristic in the Desert Soils". Storie and Mathews (1946) have described calcareous soils from the arid regions of Chile.

The distribution of lime in Australia's arid-zone soils is closely related to the pattern of soil reaction already described. The soils in the semi-arid belt and in the southern margin of the arid zone are rich in lime. As the interior and more arid portions of the continent are approached lime content decreases and many soils of the inland are virtually lime-free. Table III presents the mean percentages of calcium carbonate derived from samples of greatest lime content in soils from three separate areas of the arid zone. The data are from soils which, although dissimilar, represent the range encountered. The table indicates a general diminution in carbonate at the lower latitudes.

A limited number of analyses reported by Skerman (1947) for the channel country soils (26° south latitude) show that these are also low in carbonate. The figures reported all show less than 1 per cent. calcium carbonate.

However, many of the soils described by Stewart (1954) from the Barkly Tableland and north-western Queensland are calcareous, and it is clear that generalizations respecting the carbonate content of Australia's arid-zone soils must be treated with caution. Prescott's (1931) assertion that "most of the continent is covered by pedocals, the pedalfers being restricted to the coastal belts" is of doubtful validity. He also implied by means of

TABLE III.

Calcium carbonate contents of some Australian arid-zone soils.

Location	Range of Latitude	Number of Samples	Mean $CaCO_3$ Content %
Yudnapinna Station*	32° 15′ to 33° 40′	14	20
North-West Pastoral District, Sth. Australia†	30° to 31°	9	5.6
Northern South Australia and Central Australia‡	North of 30°	13	2.1

*Jackson (in press).
†Jessup (1951).
‡Prescott and Skewes (1938); Jackson (unpublished data).

a diagram that the arid-zone soils generally had lime horizons which became shallower with increasing aridity. This is definitely erroneous.

(f) Salinity

There is a general belief that soil salt contents are relatively high in arid areas, but few actual figures are available. Muir (1951) recorded low salt contents for Syrian soils; figures for soils from the Mojave Desert, U.S.A., show low amounts ranging from 0.014 to 0.055 per cent. (Brown and Drosdoff 1940). According to Reifenberg (1938) many of the soils of Palestine contain large amounts of salts. Ravikovitch (1953) has discussed the salinity of the aeolian soils in the Negev area of Palestine. The salt content of these soils increases with aridity, and a map presented shows considerable areas in which chloride content exceeds 0.15 per cent. Kellogg (1953) stated that salinity was generally higher in arid-zone soils than in other soils.

In Australia, Prescott (1931) observed that the zone of maximum soil salinity is located along the southern fringe of the arid region and corresponds with a zone of low rainfall per wet day. To the north, although the total precipitation decreases, the rainfall per wet day increases. Prescott also pointed out that in general fine textured soils were more saline than those of coarse texture.

Jessup (1951) and Jackson (in press) have both presented figures for total salts in the soils of the southern portion of the arid zone. The values given indicate that the fine textured soils are the most saline; figures as high as two per cent. salt are common. The least saline soils are those of coarse texture and particularly the deep sands of the desert dunes. Although many soils were sampled to a depth of six feet there is no evidence of an horizon of maximum salinity below which salt content decreases.

Salinity data on a variety of soils in the Central Australian region have been given by Jackson (1957). No significant amount of salt is present in these soils. Data presented by Prescott and Skewes (1938) on the soils from the arid interior also indicate very low salt contents. A limited number of analyses from the channel country in Queensland indicate that these soils are also non-saline (Skerman 1947).

It is therefore clear that although salt content is high in many soils in the southern arid region, the majority of the soils in the central arid interior are non-saline. There is very little information available on the ionic composition of the salts.

(g) Phosphorus Content

The amount of phosphorus soluble in boiling HCl has been determined for a number of Australian arid-zone soils. Table IV summarises the available data on surface soils thus obtained.

TABLE IV*

Phosphorus contents of surface soils in Australian arid areas.

	Phosphorus (Per Cent.)			
	<0.01	0.01-0.05	0.05-0.10	>0.10
Number of Samples	14	56	1	Nil

*Derived from Prescott and Skewes (1938), Jessup (1951) and Jackson (unpublished data).

The majority of the soils contain between 0.01 and 0.05 per cent. phosphorus but there is a big variation. Some sand dunes, for example, contain as little as 0.009 per cent. while samples of fine textured soils contain up to 0.07 per cent. There is therefore as great a variation in phosphorus content among soils of the arid areas as in soils of more humid climates. There is no indication at present that soils of arid areas generally have

either a higher or lower phosphorus status than soils of other zones.

Comparable figures for overseas arid-zone soils have not been obtained but published data are available which give total phosphorus contents of soils from South Africa (Van der Merwe 1940), Palestine (Ravikovitch 1953), and the U.S.A. (Brown and Drosdorff 1940; Marbut 1935). These total phosphorus figures have been obtained by fusion analyses and are probably slightly higher than would be obtained in an HCl extract. These data are summarized in Table V.

TABLE V.

Phosphorus contents of surface soils in overseas arid areas.

	Phosphorus (Per Cent.)			
	<0.01	0.01-0.05	0.05-0.10	>0.10
Number of Samples	Nil	9	11	9

The data are limited but it is clear that the soils of Australian arid areas, in common with Australian soils generally, contain smaller amounts of phosphorus than overseas soils.

(h) Nitrogen and Organic Matter

Most writers on arid-zone soils have stressed the fact that they contain very small amounts of organic matter and nitrogen. The percentage distribution of nitrogen in 30 overseas arid-zone surface soils and 68 surface samples from Australia are presented in Table VI.

The table demonstrates the extreme poverty of Australian arid-zone soils in respect to nitrogen.

Prescott and Skewes (1938) calculated organic carbon contents of a number of surface soils from the arid areas. The very low mean value calculated from 17 samples collected over a wide area was 0.24 per cent. The same authors also calculated C/N ratios for a number of surface soils; values ranged from 7 to 14, most samples having values of 8 to 10. These values are certainly no higher than are normally encountered in soils generally and, considered in relation to the low nitrogen figures, they suggest that the Australian arid-zone soils contain smaller amounts of organic matter than soils of overseas arid areas.

The reason for this is not clear since the Australian region is well covered by vegetation in comparison with similar areas overseas.

Conclusions

This brief review should make it clear that all manner of soils are found in arid areas and that to refer to "desert soils" as if they constituted a homogeneous group is both erroneous and misleading. The immediate task is to describe and

TABLE VI.

Percentage distribution of nitrogen content of 30 overseas and 68 Australian surface soils.

Per Cent. of Samples	Per Cent. Nitrogen				
	<0.02	0.02-0.05	0.05-0.10	0.10-0.20	>0.20
Overseas	3	30	33	24	10
Australia	13	67	16	4	—

classify the many profile forms known to exist and to characterize the soils both chemically and physically. A start has scarcely been made on the elucidation of the genesis of the soils. Current hypotheses are but loosely formulated and in most cases based on very scanty information.

The earlier Australian writings on the soils of the arid region showed a strong preoccupation with concepts of climatic zonality and surface and physiographic features. An interest in the actual soil profiles involved is of comparatively recent origin. The Australian arid region is one of the largest arid areas on the earth and is often regarded as possessing a more abundant plant cover than other arid regions. There is therefore considerable world interest in this region and frequent enquiries are made from workers overseas who are anxious to make use of Australian plants in their own dry areas. For comparative purposes a knowledge of Australia's soil environment is therefore desirable.

Such information is not plentiful but it is clear that many of the earlier notions were erroneous. The Australian arid-zone soils, for example, are not universally alkaline, lime is by no means ubiquitous, and hardpans, or desert crusts, although present, are not invariably encountered. Considerable variation exists; some soils are saline but others are salt-free; some are sandy while others are clay throughout; phosphorus contents vary as much as in any other region of comparable size.

Beyond stating that the soils are brown to red and that they contain very small amounts of phosphorus and nitrogen few generalizations are possible. Precise data are available for some areas and the appropriate references have been given above. Similar information for the remaining areas will not be available until the completion of a great number of reconnaissance and detailed soil surveys.

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APPOINTMENTS AVAILABLE

COMMONWEALTH OF AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
DIVISION OF LAND RESEARCH AND REGIONAL SURVEY
APPOINTMENT OF EXPERIMENTAL OFFICER

Applications are invited for appointment to a position of Experimental Officer with the Organization's Division of Land Research and Regional Survey located at Alice Springs, Northern Territory.

As part of the Division's programme of arid zone research, investigations are being conducted into the ecology of the Alice Springs region. Studies are proceding with a view to using native and introduced species of vegetation for increased grazing returns in conjunction with water spreading and ecological work related to range management.

The appointee will be required to conduct experiments in the reclamation and improvement of a range of selected land types in the Alice Springs region. This work will involve investigations in methods of regeneration of vegetation on degraded areas, and the study of range seeding, and will include an examination under field conditions of selected native and introduced species for this purpose, and the recording and interpretation of data from which general principles may be developed.

Applicants should possess a University degree in Science or Agricultural Science, preferably with some experience in arid zone ecology.

Commencing salary is dependent upon the appointee's qualifications and experience and will be determined within the classifications of Experimental Officer Grade I, II or III, the salary ranges for which classifications being £953-£1,403 p.a., £1,403-£1,673 p.a., or £1,773-£1,993 p.a.

The appointment will be conditional on a satisfactory medical examination and the successful applicant will be asked to serve for an initial probationary period of up to twelve months before being confirmed in his appointment as an officer of the Organization. If so confirmed he will be required to contribute to and eligible to receive benefits from either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications quoting reference number 574/13 and stating full name, place, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials, should reach the Chief, Division of Land Research and Regional Survey, C.S.I.R.O., P.O. Box 109, City, Canberra, A.C.T., by 23rd September, 1957.

EXTENSION WORK IN FARM MANAGEMENT IN NEW ZEALAND

By F. H. GRUEN*

There have been occasional suggestions that the extension services available to Australian farmers are in danger of becoming too specialised. While farmers may be able to obtain adequate information regarding seed bed preparation, pasture management, animal husbandry and disease control it is difficult if not impossible to obtain advice on the overall management of the farm. To take a specific example a farmer can obtain extension information regarding the type of improved pasture species to sow and how to plant them, but he will often look in vain for advice as to whether it would be better to spend his surplus earnings on improving yet another paddock, subdividing his farm further, buying a hay baler, or more sheep or perhaps more superphosphate for his existing improved pastures. This overall approach to the farmers' problems has become a separate branch of study overseas and in Australia—the study of farm management.

In view of the virtual absence of this type of extension work in Australia† recent developments in New Zealand may be of interest. At the present time, there are three main ways in which farm management information is disseminated among farmers in New Zealand. These three sources in order of numerical importance (i.e., number of farmers reached) are:—(1) the Farm Improvement Clubs and (2) the Department of Agriculture and (3) Lincoln Agricultural College.

The whole field of farm management extension work is a comparatively new one in New Zealand and at present the main limitation seems to be that of getting an adequate number of trained extension officers capable of undertaking this type of work. Farm management advisory services started approximately five years ago and at present about 700 farmers in New Zealand (or 1 per cent. of farms) obtain detailed farm management advice. If an adequate supply of well trained extension officers becomes available this type of work will increase in importance. Many farmers are at present on waiting lists of Farm Improvement Clubs or farm improvement projects run by the New Zealand Department of Agriculture, and cannot obtain the type of detailed management advice which is at present provided for the 700 farmers mentioned above. Of these 700 farmers, approximately 600 are obtaining extension information through the Farm Improvement Club System, i.e., from farm advisors who are paid entirely by the farmers using this advice. Approximately 60 to 70 farmers are in farm improvement projects run by the New Zealand Department of Agriculture and the remainder are obtaining farm

† The writer understands that the Tasmanian Department of Agriculture has done some work along these lines for many years, but he is not personally familiar with it.

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*The information given in this article was obtained during a four weeks visit to New Zealand in January, 1957. The writer visited several farming districts in both North and South Islands and was given some idea of the extension work carried on in farm management by the Department of Agriculture, local Farm Improvement Clubs and Lincoln Agricultural College. To some extent the information was based on personal visits to 12 farmers at the time of the visit by a farm management advisor and talking to another 20 farmers who were members of improvement clubs or groups. But in addition, it was necessary to rely on discussions with persons working in this field and on the limited amount of published work which the writer has been able to obtain.

management information from Lincoln Agricultural College.

The Work of the Advisory Services

The type of farm management service offered by these three institutions is very similar and it is possible to describe all three schemes together. The normal procedure is that when a farmer joins either a club or an improvement project or buys detailed farm management advice from Lincoln Agricultural College, a lengthy visit is paid to the farmer by the farm advisor[1] who obtains a detailed inventory of the farm resources, and information regarding the farmer's broad future objectives and his financial position. The next step is usually the preparation of a plan on the part of the farm management advisory officer. The usual purpose of such a plan will be to increase farm income, but in some cases a farmer may ask for a plan to be prepared to maintain production and income as far as possible but entailing less effort than currently expended on the farm. Such a plan will often entail changes in the basic layout of paddocks and watering facilities; changes in cropping policies, feeding methods, etc. This plan is then discussed with the farmer and modified in accordance with his wishes. The execution of the plan is "guided" by the advisory officer who visits the farm on the average once every five or six weeks. In addition, many farmers will 'phone the advisor at night to get information with regard to particular points which may have cropped up between visits. Judging from advisors' visits made to farmers when the writer was present, only a small proportion of the advice given is actually "farm management advice." Farmers ask the advisor for information regarding a large number of other topics. Questions discussed in my presence included the use of plastic materials for the cover of hay stacks, the best methods of storing silage, what type of pasture mixture to sow in "difficult" paddocks, etc. I gained the impression from meeting about 30 farmers obtaining farm management advice from different sources, that the information received in this way was of great value to the farmer and that the system under which farmers pay substantial sums (anything up to £50 a year for this advice) is likely to become a permanent feature of New Zealand farming.

The very detailed type of farm management extension available in New Zealand has a number of drawbacks, the most important of which is that each farm advisor is able to "look after" not more than approximately 50 to 55 farmers. It was realised at an early stage that intensive advice of this type would require at least a tenfold expansion in the field staff of the Department of Agriculture, and was therefore beyond the realm of practical possibility. In order to obtain such detailed advice, it is necessary that farmers pay for a substantial proportion of the cost involved. The Farm Improvement Club system was formed to accomplish this. This system consists essentially of a series of groups of approximately 50 farmers banding together to hire the services of a farm advisor. At the present time there are 11 such farm improvement groups in New Zealand.[2] The movement has grown comparatively rapidly since its inception five years ago, and if it were not for lack of trained staff, there is little doubt that the number of clubs in existence would be substantially greater. Financially the clubs work in the following manner:—farmers annually pay sums varying from £25 to over £40 each, depending on the size of their farms. To run a farm improvement club, an income of approximately £1,800 a year is re-

1. In the case of the Department of Agriculture, the advisor is the local instructor in agriculture (the equivalent of agronomists in the N.S.W. Department of Agriculture) accompanied by a farm management research officer from the regional headquarters.

2. There are actually eight Farm Improvement Clubs in existence: of these three have two groups each (i.e., they each employ two advisory officers). I have been told that the establishment of eight additional groups of this kind has been held up by lack of suitable advisory officers.

quired. Of this about £1,200 is used to pay the salary of the farm advisor and the remainder is available for his travelling expenses and to meet expenses of secretarial office work, postage, etc. (The farmers in a club elect a chairman and an executive council to represent them in their collective dealings with the advisor). To a considerable extent, the farm improvement clubs rely for specialist advice on the Department of Agriculture and other research organisations. If the farm advisor wants any soil testing done, he will take samples and get them analysed by the soil testing laboratory of the New Zealand Department of Agriculture (the club members paying for this service); if one of his farmers requires specialist advice from, e.g., a poultry or a pig expert, and the advisor feels that this problem is outside his field of competence he will get the local expert in this field from one of the regional headquarters of the New Zealand Department of Agriculture to call on the farmer.

In addition, Farm Improvement Clubs have undertaken various other types of activities. In many cases, the farm advisor will organise field days for club members at local experiment or research stations. Sometimes the field advisor will make purchases of pasture seed, and other farm requisites at wholesale prices, and enable members to make substantial savings on some of their purchases. Some agricultural authorities in New Zealand are so impressed with the improvement club movement, that they regard it as a new form of extension service which will ultimately displace the type of extension services known to us and at present provided by the New Zealand Department of Agriculture. While this seems a rather extreme view, there is little doubt that the improvement clubs have provided some healthy competition—especially in areas where departmental advice was inadequate. Judging from a fairly severe cross examination of several club member farmers I met, I obtained the impression that the clubs have provided a worthwhile service and that most farmers would continue to belong to the clubs even if there was a substantial drop in their incomes.

Another aspect of the improvement club system is that banks and other financial institutions are beginning to take a practical interest in the work being done. One farm advisor I spoke to mentioned that some banks had asked their clients to become members of a club because they felt that—in the absence of such advice—the farmer's chances of repaying his debts were small. The provision of farm management advice in such circumstances entails additional responsibility and additional work for the farm advisor who has to satisfy two masters—the farmer and the financial institution. It is possible that if the demand for such work grows, that the farm advisors will find it necessary to raise their fees for this type of work.

Results of Farm Management Extension Work

So far, no overall study of the results of this type of extension work has been made in New Zealand. However, from my contact with some of the farmers obtaining this advice I feel certain that it has been of very great benefit and has led to substantially more efficient management on the farms which are obtaining this advice. The success of these schemes can—to some extent—be judged in terms of the increase in production obtained, because in most cases, such increases are the result of better management, better use of the farmer's resources, or investments made out of the farmer's income. Table I gives some comparisons of butterfat production for four seasons for one of the clubs (the Franklin Farm Improvement Club) with butterfat production for the district (Wood, 1956).

Another comparison available relates to the South Taranaki Farm Improvement Club which has only been operating for two years. Ten members of this club supply one factory in the Whenuakura

TABLE I.

Butterfat production of district and club members.

Season	District Summary	Farm Club Summary
1952-53*	Record season	Previous record season
1953-54	Av. 10-12% below 1952-53	30% had best season
1954-55	Av. 15-18% below 1952-53	50% had best season
1955-56	Av. 10% below 1952-53	Over 90% had best season

*10 per cent. above average.

district. The club members supplied 16 per cent. of total production at one factory in 1954-55. In 1955-56 they accounted for 29 per cent. of the total increase in production of all factory suppliers.[3]

Lessons for Australia

It seems that the farm improvement work in New Zealand provides us with three main lessons. These are:—

(1) It has shown the need for continuous advice to farmers on a scale which existing extension services are not in a position to supply. Nor is it likely that sufficient funds will become available to allow the great expansion of extension services necessary to enable farmers to get visits of such frequency (say every six to eight weeks) without substantial payments by farmers for this type of service. Such continuous advice is probably necessary to lift the general standard of management on many farms. Farm management surveys in Australia and in New Zealand suggest that financial success in farming cannot be attributed—to any large degree—to the adoption of specific practices by some farmers and their non-adoption by others. The difference between good and poor farmers is largely the result of different levels of managerial ability which may manifest itself not in whether a job is done, but when and how well it is done and whether it is—at this stage in the farm's development—the most important job which has to be done. Deficiencies in this respect can probably not be remedied by means of infrequent visits (say once or twice a year) but require a more intimate contact with a trained extension officer who is in a position to observe mistakes when or fairly soon after they are made. In many cases (e.g., advice on pasture management) it is exceedingly difficult to give effective advice to farmers in the form of general principles; it is necessary to show how these principles can be translated into practice at the individual farm level.

(2) Farm management advice cannot be separated from other types of extension work. It has been suggested at various times in Australia, that farm management services should be made available to farmers. In most cases, the general idea behind such a farm management service has been that a farm management research officer should visit a farmer once or twice a year and discuss the farm accounts with the operator and perhaps make comparisons with the financial results obtained by his neighbours. Such advice will not be as valuable as the type of service at present provided in New Zealand. It may be asked whether the New Zealand type of extension service

3. It is possible to give many individual examples of the achievements of such detailed farm management advice. In the case of one dairy farmer whose shed and bails had been condemned, his bank made it a condition of a further loan that he join a club. On this basis he was granted an overdraft limit of £5,000 which was used in the first year to re-build the dairy and bails, install a higher-pressure watering system, and completely re-organise his paddock layout. As a result of these changes and other detailed advice, the farmer (with the same labour force) boosted production from 16,000 to 26,000 lbs. of butterfat in one year and in the second year (when I visited the farm) production was at the rate of more than 28,000 lbs. The increase in income (at current prices) was therefore approximately £2,000 per annum.

can properly be regarded as "farm management advice." Although, as stressed above, the farm advisor provides information on a host of other topics, the advice is essentially related to an improvement of the managerial ability of the farmer. In all cases, the basic problem is one of what improvements to undertake first and to decide what investments will give the greatest immediate return.[4] In other words, the advisor is helping the farmer to make the basic type of economic decision, i.e., the better utilisation of limited resources to obtain maximum total revenue. There is little doubt that practice at drawing up different farm budgets and being the initiator of so many farm improvement plans adds greatly to the experience and usefulness of the farm advisor. One criticism which may be made of the system in New Zealand, is that, so far, there seems to be very little comparison by either the farm advisor or the farmer of his farm's financial results in any period with those of his neighbours who are also members of an improvement group. This may be the result of the relatively short period during which these projects have been going, but one feels that one of the benefits that could be derived from organisations of this kind is the provision of comparative information on yields, productivity, etc., which would give each farmer some indication of how his performance in various fields compares with those of his neighbours.

4. For instance, in some cases farm advisors have recommended a temporary reduction in the use of fertiliser to enable the farmer to carry out more urgent improvements likely to be more productive than the equivalent expenditure on fertiliser.

(3) Another lesson which can be drawn from the New Zealand experience relates to the organisation of farm management advice. There is evidence of a certain amount of friction between the improvement club movement and officers of the Department of Agriculture. The existence of advisory officers belonging to two different organisations in one area is not conducive to harmonious relations. I have also heard complaints that improvement club members have better access to the specialist services of the Department of Agriculture than farms not included in any improvement organisations. Furthermore, as the club movement expands, the demand for soil testing facilities and specialist services from the Department of Agriculture will multiply. At present, the Department of Agriculture has been able to meet these demands but if there should be further expansion in the future, a conflict between farm improvement Club members and members of improvement projects and/or other farmers may arise. For this reason, if the farm improvement club idea is copied locally it would be advantageous that advisory officers be members of the Department of Agriculture which is charged with all other types of extension work. This should not prevent the payment of a major portion of the salary of any such officers out of funds obtained from farmers who are being given advice.

Reference

Wood, A. G. (1956)—The Farm Improvement Club Movement. Dairy Farming Manual, 1956 (Massey Agricultural College), p. 112.

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THE INSTITUTE'S SUBMISSION TO THE COMMITTEE OF ENQUIRY ON AUSTRALIAN UNIVERSITIES

At its meeting in Sydney on 15th March, 1957, Council considered presenting evidence on agricultural science to the Committee of Enquiry on Australian Universities. Believing this action was desirable, Council requested Sir Samuel Wadham to convene a committee to frame an Institute viewpoint for Council to consider and present to the Committee.

Sir Samuel accepted this task, and formed a committee comprising Mr. P. Ryan, Professor H. C. Förster, Dr. I. F. Phipps and Mr. J. A. Roberts. This committee met on 16th May, 1957 and prepared a draft submission which was circulated to members of Council on the following day.

In the meantime, Council had decided that as the submission needed to be in the hands of the Secretary to the Committee on Australian Universities by 10th June, 1957, it should be finalised on Council's behalf by the Executive Committee.

Council's Executive Committee, consisting of the President, Dr. W. A. T. Summerville, Hon. General Secretary, Mr. R. G. Downes, Hon. General Treasurer, Mr. A. N. Waite, and the Executive Officer, Mr. J. A. Roberts, met Sir Samuel Wadham on 30th May, 1957. The draft submission was considered in conjunction with comments from the Principal Delegates of all Branches of the Institute, and completed that evening.

1. The Institute

The Australian Institute of Agricultural Science, an incorporated body, is the professional body which is concerned with the welfare of scientists whose work is connected with the rural industries either in research, in teaching and extension services, in commercial enterprises connected with farming and its products, or in administration. (Nearly all its members are graduates.)

The Institute is continually mindful of the important part played by agriculture in the economy of Australia. Agriculture employs 13 per cent. of the labour force, and provides 86 per cent. (1949-1954) of the value of exports from this continent. In the maintenance and efficiency of this widespread industry all bodies in the Commonwealth and State services, the universities and industry make their contribution. They all look to the agricultural faculties in the universities for the provision of a large proportion of their officers. The Institute integrates the professional interests of all scientific workers serving agriculture.

2. Its Interest in Education

In recent years the Institute has been concerned at the shortage of students presenting themselves for training in Agricultural Science at universities. It has conducted campaigns to overcome this deficiency. It is consequently concerned to some extent with each stage in the general educational scheme from the High Schools upwards. Naturally every aspect of university training for the profession of agricultural science is of primary importance to it.

3. Purpose of Agricultural Education in Universities in Australia

In the Australian Commonwealth the great majority of farms are run on a family basis with a man and his son, or sons providing the labour force. Larger properties do occur, especially in the pastoral industries; on these properties paid

management and labour are employed; but such properties form only a small proportion of the total number of farms, although they occupy a large proportion of the farming area of the continent.

This means that the opportunities for employment as managers, other than of the family-run farms, are relatively few. Largely because the farms are specialised, the number of farmers who have thought it worthwhile to send their sons to the university is relatively small, so that university faculties have not been called on to bias their courses on the management side, like some universities in the United Kingdom. On the other hand, the range of farming conditions in every mainland State is far greater than in England, or in Scotland, so that if a graduate is to be sufficiently trained to grapple successfully with the range of problems he will meet as an advisory officer his basic training must contain considerable grounding in the principles of general science. If his training were of a more empirical nature he would find the task of interpreting and resolving many of the problems which he will meet when acting in an advisory capacity beyond him; further, he would lack sufficient basic scientific training if he is called on to do research work.

The main endeavour of the University Agricultural Schools in Australia has therefore been to train agricultural scientists:—

(a) for research into the innumerable problems which still remain unsolved in the wide range of fields which are concerned with agricultural progress;
(b) for advisory work either as specialists, or in agricultural districts, or industries;
(c) as teachers in Agricultural High Schools and Colleges, and
(d) to a lesser extent, for the management of farms.

4. Courses in the High Schools

We believe that these should be a matter of interest to the Committee from two points of view:—

(a) In some States the universities control the public examinations directly, and in others their indirect influence is considerable. Even where State Education Departments are chiefly responsible the heads of those Departments are usually university-trained and their attitude is influenced by university traditions. These public examinations are regarded by most sections of the community as educational hall marks. The ability to pass them is regarded as important in grading boys and girls for selection for many occupations. If therefore these tests are not effectively organised and do not conform in their scope to those standards which modern educational research has shown to be effective, then the general standard of training in the schools may be too low, or it may be biassed in such a way as to fail to influence the pupils towards the kind of studies which are most essential for modern life.

(b) A potentially valuable source of university students exists in the country High Schools and there is some evidence to suggest that the number of pupils who stay on at country High Schools after the Intermediate Standard (ages 14-16) is too low. As a result an insufficient number of boys and girls are brought into contact with the more advanced stages of school education which are essential if they are to be effectively equipped for the profession or for acquiring those skills which are becoming more and more essential in the modern world.

(c) Even where High School students do not pursue their formal studies to higher levels the fact that they have made contact with this wider field of knowledge should make them more receptive of new ideas at the hands of extension officers.

The reasons for leaving High School too young are various, but in the country High Schools at least it seems likely that some pupils of ability persuade their parents to let them leave school because

they feel that the subjects which they can study, if they remain longer at school, are out of touch with the realities of life. Agricultural Science is being taught in an increasing number of schools, and is a type of subject which can be made to interest country boys, but this is only one subject. It is suggested that the mental equipment of a boy for the modern world could be greatly stimulated by a course in applied science, the basis of which would be largely descriptive and could deal with the scientific reasons for the properties of such substances as metals, wood, clays, the basic principles in the design of various machines, the structure of the animal body, the functions of its parts, etc.

This course would not specifically train students for the universities (any more than agricultural science in the public exams trains them for entry into the agricultural faculties), but it would give the boys some systematic information about the scientific reasons for many of the things they are sure to encounter in later life. Further, it is reasonable to expect that at least a few of the lads induced to stay on at High School beyond 16 years so as to get this attractive course would develop a taste for more knowledge and swell the ranks of those who pass into the universities.

We are aware that this proposal may be held by some to violate traditional educational policies, but if traditional systems are failing to encourage enough students then it is time that experiments were made in other directions.

One comment on these proposals may be that neither the teachers nor the equipment are available for such a school course. Arguments of this type are arguments of despair. The universities should have courses which are wide enough to train the teachers suitably and the cost of the equipment would be no greater than that needed for teaching scientific subjects of the classical type.

If these views are accepted then there is need—

(a) for the universities to consider the courses for their degrees in the light of the requirements which the teaching authorities would make if the latter propose to take action along the line indicated.

(b) for the universities, or other authorities to frame new non-academic curricula for some of the public exams which they control.

5. The Courses in the Agricultural Faculties at the Universities

These vary considerably in their construction. In general, they rely on the schools of the science faculty to provide the training in basic science of the first year. The later years consist of a mixture of pure and applied science with some study of economics as applied to agriculture. A wide range of subjects is necessary, including an acquaintance with subjects such as the principles of statistics, climatology, the history of land development and land laws, marketing of farm produce—all these in addition to botany, zoology, genetics, chemistry of soils, physiology and biochemistry and geology in relation to land form and soil formation.

The method of acquiring practical experience varies. In some universities the Agricultural Colleges are used: in others commercial farms. In some, the experience is acquired during one year of the course, in others it may be distributed.

The Institute does not suggest that any one method of giving the instruction is better than the others, and for that reason it has not attempted to provide the Committee with an analysis of the various courses. Its concern is with five main problems which have appeared in greater, or less degree in the various faculties of agriculture.

(a) In some universities insufficient finance has been available for the adequate staffing of the faculties of agriculture.

(b) The number of students who fail to pass the examination at the end of

the first year. This is particularly large in those universities where it is practice for the lecturers in the first year science subjects to assume a considerable amount of basic knowledge on the part of the students at the outset of their university courses. The Institute does not think that the standard of the students on entry is abnormally low, nor is it urging that the standard required at the end of the first year is too high. The difficulty is that either the methods of teaching in, say, Chemistry I are not effective or that the examination system is defective. There are logical grounds for holding that the former is the true reason. The change from the normal teaching methods used in schools to the system of instruction by lectures is considerable. Again, the number of new concepts, many of them somewhat complicated, which a student is expected to understand and absorb into his mental processes for dealing with a scientific problem is too large for students at that stage of mental development. If this reorientation of thinking method is to take place effectively, a system of tutorial classes with small groups is essential. The difficulty is that personnel for performing this tutorial function does not at present occur in the universities, and is not generally available to them from outside. This difficulty may be overcome by some increase in the number of young research workers on the university staff, in organisations attached to the university or which have an appreciation of the university's needs.

Another line of exploration which might be tried in connection with this very important matter would be to ensure that each lecturer in first year science subjects has attended a course in the principles of giving instruction.

(c) The extent to which specialisation should be permitted (or encouraged) in courses for a first degree is debatable. Some universities allow considerable specialisation in the final year of the course for a first degree in agriculture, others do not. It is generally agreed that in an unspecialised course it is not possible to train students to a research standard at the first degree stage. Consequently, in those agricultural faculties in which the course is a generalised one, it is very important that all students who are capable of doing research and are perpared to undertake it should have the opportunity to get this further training. This involves ensuring that financial provision for their support and tuition is available. In those agricultural faculties in which specialisation is arranged during the final year this further financial assistance will also be necessary because the transition of a mind from a stage in which it is being taught through the medium of lectures to one in which it is acquiring the habit of critical and constructive approach to problems is not a simple process. If it is to be effectively achieved this transformation requires, in most students, a period of maturation without which the research worker is liable to be dogmatic and poorly balanced in outlook.

(d) The problem of retaining these post-graduate workers is therefore important in the development of a supply of well trained research men both for governmental instrumentalities, whether State or Federal, or for employment by the larger commercial organisations dealing with agricultural products or supplies. The same problem is of equal significance to the university faculties of agriculture because if the teaching staffs in these faculties are to be "alive" to the advances being made in their subjects they must be engaged in some research, otherwise they will degenerate into pedagogues. This direction of a small group of young research workers is one of the most effective ways in which a progressive outlook can be maintained. In this way, if the leadership is well bal-

anced, the sense of team work, which is important in most branches of modern science, can be developed.

The problem is to decide the method by which the finance for these groups can be obtained. Generally, the faculties of agriculture, being small in size, cannot claim any very large share of the skimpy general research funds available to their universities. Private benefactions have been available in varying amounts but the value of nearly all of these has depreciated markedly with the inflation of recent years. The Rural Credits Development Fund of the Commonwealth Bank has been the chief source in recent years, and although the Bank exercises some control over the type of agricultural work it is prepared to support, those responsible for exercising that control have generally shown considerable wisdom. In recent years some of the bodies responsible for guiding policy in the development of farming industries and the sale of their products have taken more interest in research and although their support has mainly been given to C.S.I.R.O., smaller portions have from time to time been allocated to universities. Whatever its source the amounts of money available to agricultural faculties has been too small.

(e) The question of the amount of money which should be allocated for research and research training is important. The Institute does not suggest that every faculty of agriculture should aim at training post-graduate students for research in every subject. Such a scheme would not be warranted in subjects for which the demand for research workers or for men in commercial posts is likely to be small. Entomology, dairy technology, and nematology are examples. On the other hand, the widespread importance of certain other fields of study is so great that every faculty should have some workers training in them. Crops and/or pastures, animal studies of various types, rural economics and soils are in this group. Students wishing to specialise in a subject of the former group and who have demonstrated a capacity for such work should transfer for post graduate work to some other university which is a centre of research in that subject if training in it is not available in his own university. It will be far cheaper to provide research and maintenance grants for such research trainees than to build up a special research group at each university centre. In this way highly skilled manpower will be used more economically and the pressure of a small group of such workers drawn from differing backgrounds at a centre should be stimulating to all concerned. Naturally this implies that research in each of the minor subjects should be carried on in at least one university or other centre of investigation.

The Institute holds the opinion that the primary function of the university faculties of agriculture is to teach effectively. To do this their teachers must be in contact with active research and, as already shown, their teaching does not end with preparing students for a first degree. In our opinion, there is no better way of doing this than by ensuring that they undertake an investigation themselves, or are responsible for the close direction of research students.

Whatever the students' geographic distribution it is important that those who have shown promise of an aptitude for research should have reasonable financial provision, including maintenance where necessary. However, they are still under training and they will ultimately be able to take out higher degrees which should give them a higher claim for advancement than those who have obtained full salaried employment immediately after graduation. It is suggested that the basic salaries of men in this stage of training should be not less than three-fifths of normal pay in the first year, and four-fifths in the second year (during which stage

they will probably be completing their qualifications for a Master's degree). The expectation is that, at the Ph.D. degree level, they will be able to rise in the outside world to higher salaries than those which graduates whose academic training stopped at the Bachelor's degree would be receiving.

Students for Higher Degrees as Demonstrators

Every graduate who is under training for a higher degree should be liable to act as a demonstrator or tutor in those classes for which his services are required. Such demonstration should not occupy more than six hours per week of university term. He should be paid for this work at standard rates. The reasons for this are as follows:—

(a) Acting as a demonstrator actually makes a student learn many things he failed to learn as a student.

(b) It helps him to appreciate the need for clarity of thought and expression.

(c) It provides the university with a staff of junior teachers without which its system of instruction is apt to fail.

(See para. 5 (b) above.)

The Need for Facilities for Field Experiments

In many fields of agricultural enquiry the use of farm lands and/or equipment is necessary. Some universities therefore have acquired farms for their purposes. The cost of acquiring such farms is usually high, and the annual cost of maintaining them at a standard which is creditable to the institution concerned is also high. It is fallacious to expect the farm to produce sufficient profit to pay interest on the capital sunk into it. Many experiments have to be conducted in such a way that there is no hope that the return to the farm in commodities sold can cover the cost of running them. As a general result experimental farms are a continual drain on the resources of a faculty. They are also very demanding on the time of its senior members and some, or all, of whom must bear the responsibility.

The alternatives are to use State farms, or those of Agricultural Colleges, or, in the case of experiments which make no great demand on buildings and equipment, to obtain the aid of private farmers or landowners.

The Institute makes no further comment on the matter except to point out that facilities for such experimentation are essential and local circumstances may decide which method of acquiring them is most effective and, at the same time, reasonably economical.

The Need for Interchange Between Staffs

From time to time cases have occurred in which the general good would have been served by an officer changing his work from that of a State Department, or of the C.S.I.R.O. to a university, but difficulty has been experienced in respect to the transfer of pension rights. The Institute is of opinion that the pension rights of State Departments, universities and Commonwealth should be transferrable in either direction.

6. Recommendations

The Australian Institute of Agricultural Science presents the following recommendations in respect to the place of Agricultural Science in the Universities:—

Education in Country High Schools

1. In order to encourage more country boys and girls to remain at school and develop useful skills and practical knowledge, the universities institute examinations in a composite subject in applied sciences at Leaving level.

The University Course

2. That better financial provision should be made in order to maintain more adequate staffing and equipment for the agricultural faculties.

3. That the universities should expand tutorial services, especially in the first year of the course, in the expectation that the failure rate will be reduced.

4. That the universities need candidates for higher degrees to undertake

tutorial and/or demonstration duties, thus providing the staff for this work.

Post Graduate Training

5. That the universities be enabled by Governments and industries to afford more training in research in the main subjects of the agricultural faculties and, further, that adequate provision should be made to establish in at least one centre in the Commonwealth adequate training in each of the more specialised subjects.

6. That more scholarships should be provided with the object of increasing the number of students undertaking post graduate work at the agricultural faculties of the universities.

SUBMISSION BY THE QUEENSLAND BRANCH OF THE INSTITUTE TO THE COMMITTEE OF ENQUIRY ON AUSTRALIAN UNIVERSITIES

This submission by the Queensland Branch of the Australian Institute of Agricultural Science is supplementary to the general submission prepared by the Institute, and is concerned with matters of particular reference to the teaching of agricultural science in this State. It was drawn up by a committee consisting of Mr. N. H. Shaw (President of the Queensland Branch), Dr. D. O. Norris, Dr. L. G. Miles and Mr. W. W. Bryan.

There are several features of Queensland agriculture which require special consideration. Quensland is situated in the tropics and sub-tropics and its agriculture therefore differs markedly from that in the rest of Australia. Many forms of animal production and crop raising are carried on in common with other States, but because of climatic differences the problems are different. In addition, some of the tropical crops such as sugar-cane, sorghums, pineapples and other tropical fruits are important, and are not raised to any extent anywhere else in Australia. Other tropical crops such as tea and coffee can be grown, but at present they cannot be produced economically in competition with other tropical countries with cheap labour. This position could be altered by research into all aspects of production and possibly as a result of political changes now taking place in several tropical countries. Altogether we submit that agriculture in Queensland has special features which demand a strong agricultural faculty in the University, capable of placing teaching emphasis on these special features.

The Agricultural Science Course at the University of Queensland

It is not intended to discuss this course in detail, but we will refer to several aspects needing emphasis.

(1) *Staff*

We submit that there is urgent need to increase the staff of the faculty to provide for a wider range of specialist subjects for post-graduate study, strengthening of teaching in the final years of the degree course, and the elimination of courses which are "borrowed" from other faculties. These "borrowed" courses in the basic sciences are a continual source of trouble both to faculty members and to students, and at best they can only be regarded as an unsatisfactory compromise. One cannot expect to get a satis-

factory course, in say Agricultural Chemistry, by selecting sections of a chemistry course designed for analytical chemists.

(2) *Vacation Training*

Practical training in the long vacation is obligatory and is an essential part of an agricultural science course. This training is obtained on private farms, research stations, and at the Queensland Agricultural College. It is recommended that some financial assistance is necessary to ensure that students can get the type of training best suited to their particular needs. This might take the form of travel grants to enable a student resident in say Brisbane, to travel up to 1,000 miles to obtain practical experience on a sugar farm in north Queensland, or of a grant to enable a student to work at a particular research station (such stations do not always have funds available to employ students).

(3) *Facilities for Laboratory and Field Work*

Improved facilities for laboratory, glasshouse and field work in agronomy and related subjects are urgently needed. The conduct of experiments is an integral and most important part of the student's training, and present facilities impose a limitation on the type of experiment that can be attempted. The University has recently been given a small farm at Redland Bay, but it cannot hope to develop this in a manner suited to student training with its present finances.

(4) *Post-Graduate Courses*

We believe there is scope for an increase in the specializations available for post-graduate study. At the same time we agree fully with the recommendation from the Federal body of the Institute that every faculty of agriculture should not aim at post-graduate training in every subject. It is considered that Queensland University, because of its geographical position, should aim to provide post-graduate study in tropical aspects of the various subjects, and particularly in tropical agronomy and agrostology.

(5) *University in North Queensland*

It is recommended that the time is appropriate for provision of University courses in North Queensland. There are many general considerations applying to all faculties in support of this, such as distances students must travel at present to reach the University in Brisbane, but in the case of agricultural science there are special considerations. Development of the agricultural and pastoral industries in tropical Australia is an urgent requirement for both economic and political reasons, and this will demand a supply of graduates trained in tropical agriculture. Trinidad is the only centre offering such training in the British Commonwealth at the moment, and this undoubtedly restricts the supply of personnel. Further, tropical agriculture in other countries is concentrated in the wet tropics whereas in Australia it is the dry tropics as well as the wet tropics which need developing. Altogether we consider that we must be prepared to train our own people, and if this is to be done properly, then a University College in the north is essential.

Matriculation Requirements and Courses in High Schools

These matters have already been discussed in the submission from the Federal body of the Institute. We have a number of points to add.

In Queensland the University controls the public examinations leading to entry into the University, This, together with matriculation requirements, gives the University a large measure of indirect control over the subjects taught in schools.

The biological sciences are of supreme importance to agriculture and agriculture is the prime basis of the Australian economy yet, paradoxically, the biological sciences are scarcely taught at all in Queensland schools and this applies particularly to boys' schools. For instance,

to the best of our knowledge it is virtually impossible for a boy to study botany at school. This lack must have a considerable influence on the numbers offering for courses in the biological sciences at the University.

We believe that one of the main reasons why biological subjects are not available is the traditional emphasis on chemistry and physics for matriculation requirements. To matriculate for Agricultural Science a student must have a Senior pass in either chemistry or physics and a Junior pass in the other. We can see no reason why early training in say botany would not be just as valuable to a student. So long as students are *obliged* to study chemistry and physics at school, as well as the other obligatory subjects, it is impossible for them to find time to study one of the other sciences such as botany, zoology and geology. We believe that matriculation requirements should be widened with these points in view and students actively encouraged to take biological courses.

There is no valid reason why the disciplines of chemistry and physics should expect their first year students to present themselvse equipped with a high standard of preliminary knowledge in these subjects, while the disciplines of zoology and botany should be content to assume nil knowledge and begin from fundamentals, as is the case at present. This situation is a traditional one only. We believe that attention to this point will result in an increased flow of students entering the biological faculties, will make the teaching task of these faculties less onerous and more effective, and will result in a great contribution to the real needs of the community.

In the same way, and with particular reference to the agricultural faculty, we believe that an agricultural college in north Queensland would have far reaching effects both on the development of agriculture in tropical Australia, and on the numbers who study agriculture at the University. At present boys may have to travel 1,000 miles to reach the Queensland Agricultural College at Lawes.

ERRATA

The following corrections are made to the list of Theses published in the June, 1957, issue, Vol. 23, No. 2, page 159.

(1) The degree awarded by Melbourne University to C. R. Millikan in 1951 was D.Sc. (not Ph.D., as was wrongly recorded in Vol. 23, No. 2).

(2) In the title of the thesis by Dorothy E. Shaw, awarded the degree of M.Sc.Agr. by Sydney University in 1953, *"stagnosostoria"* should have read *"stagonospora"*.

(3) In the title of the thesis by D. E. Harrison, awarded the degree of M.Agr.Sc. by Melbourne University in 1955, *"spendonocum"* should have read *"sepedonocum"*.

(4) The name of the recipient of a M.Sc. degree awarded by the University of Adelaide in 1956 was K. Kanapathy (not K. Kandasamy).

EVALUATION OF ROOT EFFICIENCY IN MOISTURE EXTRACTION

By N. G. DASTANE

The root system of a species constitutes an important factor in soil moisture and plant relations. Therefore, while selecting species and varieties for areas with deficient soil moisture supply, efficiency of roots in absorption of moisture becomes one of the valuable characteristics. Characteristics of roots in absorption of water have been examined and discussed by several workers in comprehensive studies (van Dillewijn 1952; Kramer 1949; Teakle and Jones 1941; Weaver 1926; Weaver and Bruner 1927).

Stevenson and McIntosh (1935) concluded that mass of roots is not a deciding factor as far as absorption of water is concerned. That abundance of roots is not necessarily a measure of either the rate or the amount of water removed from a given depth was reported by Hoover *et al.* (1953). Evans (1937a) found no correlation between the length of roots and their absorbing surface. In his later studies, (1937b, 1939) he introduced the concept of the ratio of total leaf surface to total absorbing surface of roots and proposed that this ratio would be a valuable guide in selecting varieties from areas with deficient moisture supply. However, determination of such a ratio is laborious from a practical point of view. Conrad and Veihmeyer (1929) and Corey and Blake (1953) concluded that the extent of lateral and vertical spread and the nature of the distribution of roots are the most important characteristics associated with the amount of moisture the roots can absorb from a soil.

In the light of the observations of these workers and the inconclusive results, these studies were organised to evaluate efficiency of roots in absorption of moisture. Investigations were designed to observe:—

(a) The response of roots when soil moisture is at a tension equivalent to the permanent wilting point and may be considered to become unavailable for growth in root zone,
(b) Whether root systems of two varieties differ in their capacity to extract soil moisture below the permanent wilting point,
(c) Whether the roots differ in their capacity of elongation when moisture content of the surrounding soil is below the permanent wilting point.

Materials, Methods and Results

Choice of Varieties

Three varieties of sugar cane were selected for study, namely Pindar, Queensland 47 (Q.47) and Canal Point 29/116 (C.P. 29/116) which were known to differ in their drought tolerance. Pindar is a drought susceptible variety while the other two are drought tolerant.*

Capacity to Extract Moisture

Cane plants of the three varieties were grown for two months in 6in. x 4 in. bakelite pots holding about 4 lb of air dry soil. It was observed that the roots permeated quite evenly throughout the soil

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*A "drought tolerant" plant suffers a smaller reduction in yield of cane and cane sugar under conditions of soil drought than does a "drought susceptible" plant.

mass during this period. The pots were watered, the soil surface was sealed with paraffin wax and then they were left unattended till all the shoots dried (6 weeks) and died by the water stress. The soil was then sampled and the moisture content determined.

Table I records moisture percentages to which the soil was depleted by these varieties on four different occasions. The permanent wilting point of the soil, as determined by the sunflower method, is 9.2 per cent.

Analysis of variance shows that the differences in moisture content of the soil are not significant. The three varieties, although different in their drought tolerance, are similar in their capacity to extract soil moisture.

TABLE I

Soil moisture content in pots after the death of plants.
(Average of eight readings, moisture content on oven-dry basis.)

Occasions	Varieties		
	Pindar	Q.47	C.P. 29/116
I	7.26	6.43	6.60
II	6.91	6.86	7.71
III	8.38	7.76	7.84
IV	7.29	8.03	7.15
Mean	7.45	7.27	7.32

Capacity of Roots to Extend

Cane plants of the three varieties were grown from setts for about eight weeks in Sisalkraft paper containers holding fine sand. The containers were about 5 in. in both height and diameter and cylindrical in shape. One plant was grown in each.

During the growth of the plants, 50 ml of a 'complete' solution (Meyer and Anderson 1947) were added weekly to supply nutrients. The plants grew well and it was observed that the root system ramified thoroughly in the sand mass during the period of eight weeks.

At this stage, the bottom of the paper container was removed and the culture was transferred to a flower pot already filled with soil to half of its depth. The flower pot was 12 in. in height and 9 in. in diameter at top. After the transfer, the paper container was removed and the flower pot filled completely with the soil. The procedure is illustrated in Figure 1. The flower pot was watered to field capacity and then left unwatered till one of the varieties died. This took six weeks.

During this period, the moisture in the sand which was already occupied by roots, was rapidly depleted and roots had to extend into the surrounding moist soil for more moisture.

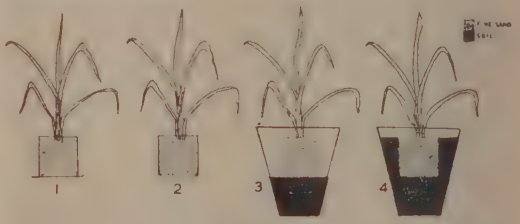

Figure 1.
Procedure adopted for studying the capacity of extension of roots.
(1) Cane plant in a paper container holding sand.
(2) Paper container with bottom removed.
(3) Paper container transferred to a flower pot containing soil. Sides of paper container removed.
(4) Flower pot completely filled with soil.

At the end of six weeks, when Pindar plants died, the roots in the sand and the soil of all varieties were separated after emptying the pots by inverting them. There was a distinct demarcation between the soil and the sand zone which made the separation of the roots very easy. The roots procured were washed, dried and weighed.

TABLE II.

Capacity of the roots to extend.
(Dry weight of extended roots in gms.)

Replicates	Varieties		
	Pindar	Q.47	C.P. 29/116
I	0.06	0.41	0.52
II	0.03	0.23	0.37
III	0.02	0.32	0.33
IV	0.11	0.24	0.68
Mean	0.055	0.300	0.475

Significant difference at 5% is 0.170 gm.

Analysis of these data (Table II) indicates that the three varieties differed significantly in their capacity for root elongation. C.P. 29/116 has the greatest capacity to extend when the moisture conditions become adverse. Q.47 is intermediate while Pindar is very poor in this respect.

Discussion

The root criteria looked for in these studies were capacity to extract moisture below the wilting point and the capacity to extend from a region at a high moisture stress into a region of low moisture stress.

All the varieties of cane had reduced the soil moisture to about two per cent. below the wilting point by the time the aerial portions of the plants had died. Even though this moisture below the permanent wilting point is not useful for maintaining turgor and supporting growth, it may be vital for the survival of the plants during drought periods. No varietal differences were noticed in the capacity to extract moisture at tensions greater than the permanent wilting point. This capacity depends upon a number of factors, important among which will be the distribution of roots in the medium and the magnitude of diffusion pressure deficit developed in the leaves. Assuming that the root distribution was thorough, it can be concluded that this capacity did not differ significantly in these three varieties which exhibit substantial differences with respect to drought tolerance.

As the moisture in the vicinity of roots is depleted to wilting point, the movement of soil moisture into this area of high moisture tension from the surrounding mass of soil, at low moisture tension, becomes slow. In order to tap more moisture, it is necessary for the roots to elongate into the soil mass at low moisture tension where there is sufficient moisture available. Symptoms of moisture stress by a plant mean that the moisture is exhausted only from the root zone and not from the whole field. With this idea in view, the ability of roots to elongate from sand with high moisture tension into surrounding moist soil was assessed in these varieties. Significant differences were observed. Pindar was found to be extremely poor while Q.47 and C.P. 29/116 were found to have comparatively better ability to extend roots from a region of high moisture stress to a region of low moisture stress.

Thus this capacity to extend roots from dry soil into moist soil is a valuable characteristic of a species enabling it to tide over dry spells during its growing period, and it may serve as an indicator of drought tolerance.

Conclusions

The techniques described are useful to show—

(1) The efficiency of the roots in absorbing moisture and in reducing the soil moisture below the permanent wilting point.

(2) The capacity of a well established root system to extend into the moist soil from a base of low water supplying power.

Acknowledgements

The writer wishes to express his sincere gratitude to Professor L. J. H. Teakle and Dr. G. L. Wilson of the University of Queensland for their valuable guidance and helpful criticisms. Grateful acknowledgement is made of the award of a Junior Fellowship under the Technical Cooperation Scheme of the Colombo Plan offered by the Governments of the Commonwealth of Australia and of India, which made it possible to prosecute these studies.

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BOOK REVIEWS

SALMONELLOSIS IN ANIMALS, a review

By A. BUXTON

(*Department of Veterinary Pathology, University of Liverpool.*)

(*Commonwealth Bureau of Animal Health, Review Series No.* 5. *Medium octavo with stiff cover, pp.* v + 209. *Over* 1,750 *references. Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne, C.2, Victoria. Price* 31/3.)

This is a comprehensive review of the *Salmonella* infections of domestic animals and poultry, fur-bearing animals, rodents, reptiles, insects and ticks.

The main chapters cover: general characters of the organisms; classifications; distribution of species in animals; symptoms and lesions; epidemiology; immunology; chemotherapy and disinfection; and public health aspects.

Numerous tables are included, the more extensive of which deal with the antigenic structure of sefotypes; the host species of serotypes; and the fermentation reactions.

Veterinarians, whether engaged in research, teaching or practice, and medical workers in the field of public health will find it an invaluable reference book.

NEOPLASMS OF THE DOMESTICATED MAMMALS, a review

By E. COTCHIN

(*Commonwealth Bureau of Animal Health, Review Series No.* 4 (*pp. xv* + 100). *Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne, C.2., Victoria. Price* 25/-.)

The book is a guide to the literature on the neoplasms of domesticated and laboratory mammals.

The opening chapters deal with nomenclature; incidence in mammals; surveys of tumours in different species; metastasis; "primary multiplicity", and aetiology.

The main part of the book then considers the tumours under the different organ systems with sub-headings for the individual species. There is a very extensive bibliography.

The author is E. Cotchin of the Royal Veterinary College, Camden Town, London, who has made a special study of the tumours of domestic mammals for more than ten years.

The book should be an indispensable reference work of interest not only to veterinarians but also to human pathologists interested in the comparative aspects of cancer in man.

SOME EFFECTS OF INDUCED AUTOPOLYPLOIDY IN WHITE CLOVER, BARREL MEDIC AND WIMMERA RYEGRASS

By E. M. HUTTON

Summary

Induction of autopolyploidy in white clover (*Trifolium repens* L.), barrel medic (*Medicago tribuloides* Desr.), and Wimmera ryegrass (*Lolium rigidum* Gaud.) decreased agronomic value except possibly in barrel medic. Increased ploidy produced some interesting effects. In autopolyploid white clover there was a marked intensification of cyanogenetic activity coupled with a coarsening of the plants. Autotetraploid plants of *Medicago tribuloides* were later maturing, but burr type was not greatly affected except in 12725 in which spine length was increased 30 per cent. With Wimmera ryegrass tiller production was reduced by 48 per cent., node and stem diameter were increased, and there was an intensification of the purple pigmentation of the stem often accompanied by a pronounced geniculation.

Introduction

The success and limitations of induced autopolyploidy as a plant breeding technique have been reviewed by Stebbins (1956). In general the technique has not been outstandingly successful but in a number of crops, for example, white clover, rye, turnips, ryegrass, watermelon, and sugar beet some improvements have been effected.

Effects of induced autopolyploidy in some important Australian pasture plants have been investigated. Hutton and Peak (1954) showed that of the five varieties of subterranean clover (*Trifolium subterraneum* L.) studied only Dwalganup gave a favourable response. This paper records the more interesting changes which followed induction of polyploidy in white clover, barrel medic, and Wimmera ryegrass.

Materials and Methods

Seed of commercial Wimmera ryegrass and New Zealand certified white clover was used. Two strains of *M. tribuloides*, 173 and 12725, were obtained from Mr. W. D. Andrew, Division of Plant Industry, Canberra.

Five hundred seedlings of each legume were raised in flats of soil in the glasshouse. Soon after emergence cotyledons and epicotyledonary buds were painted with a solution containing 0.4 per cent. colchicine and 0.2 per cent. of the spreader "Gardinol K" as described by Hutton and Peak (1954). Treatment was given each afternoon for a week and resulted in the death of 25 to 30 per cent. of the plants. A month after treatment, 48 white clover plants, 30 of *M. tribuloides* 173, and 23 of *M. tribuloides* 12725 were selected as possible autopolyploids. Each selected plant was transplanted to a 7 inch pot. At flowering autopolyploids were distinguished by their larger pollen grains and stomates. 12 plants of white clover, 10 of *M. tribulaides* 173, and 8 of *M. tribuloides* 12725 were retained as autopolyploids.

One thousand seedlings of Wimmera ryegrass were raised in flats of soil. Fourteen days after emergence the seedlings were cut back about 0.5 cms. above the soil surface with fine scissors kept wet by dipping in the colchicine solution and the cut surfaces were then painted immediately with more colchicine solution. The new growth produced next day and on the three subsequent days was treated in a similar manner. This resulted in a 75 per cent. mortality and the selection of 52 apparent autopolyploids. Of these only 15 were selected finally on the basis

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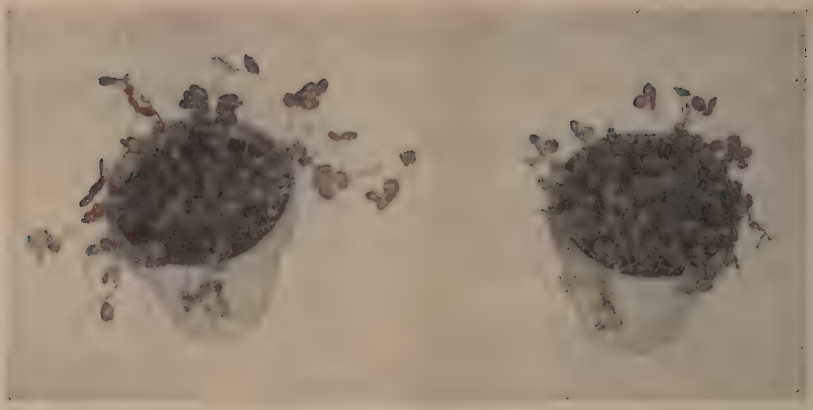

Figure 1.
Autopolyploid white clover on left and normal on right.

of greater pollen grain size and reduced pollen staining in alcoholic solution of iodine.

Chromosome counts of normal and autopolyploid strains were made in root-tip squashes. Acetic orcein was used in the legumes and Feulgen staining in Wimmera ryegrass.

Cyanogenetic reactions of progenies from normal and autopolyploid white clover plants were determined by the picrate paper test described by Williams (1939). Colour reactions were classified in the categories YO, Y1, Y2, OR1, OR2, R1, and R2 representing progressive colour changes from bright yellow to bright red.

Cyanogenesis and Autopolyploidy in White Clover

An autopolyploid white clover plant is compared with a normal one in Figure 1. The autopolyploids had 64 chromosomes and the normals 32 chromosomes. The autopolyploid is more open than the normal plant and has coarser stems and larger leaves. In the field, autopolyploids were less vigorous and persistent than normal plants.

Approximately 500 C_1 generation plants of autopolyploid white clover were grown in the field from seed obtained by allowing the 12 C_0 plants to intercross. At the same time, a similar number of normal plants were grown from the original seed. All plants were sampled and tested for cyanogenetic reactions during the same 8-day period. One hundred plants were selected at random and re-tested and 90 per cent. gave the same test as before, the rest being displaced one colour class above or below that in which they were previously. Results are summarised in Table I.

TABLE I.
Effect of autopolyploidy on cyanogenetic reaction of white clover.

No. of Plants	Chromosome No. (Somatic)	Percentages of plants giving the different colour reactions						
		YO	Y1	Y2	OR1	OR2	R1	R2
490	32	20.0	21.0	5.7	30.0	10.0	13.3	0.0
492	64	1.2	1.2	0.0	16.5	3.5	56.9	20.7

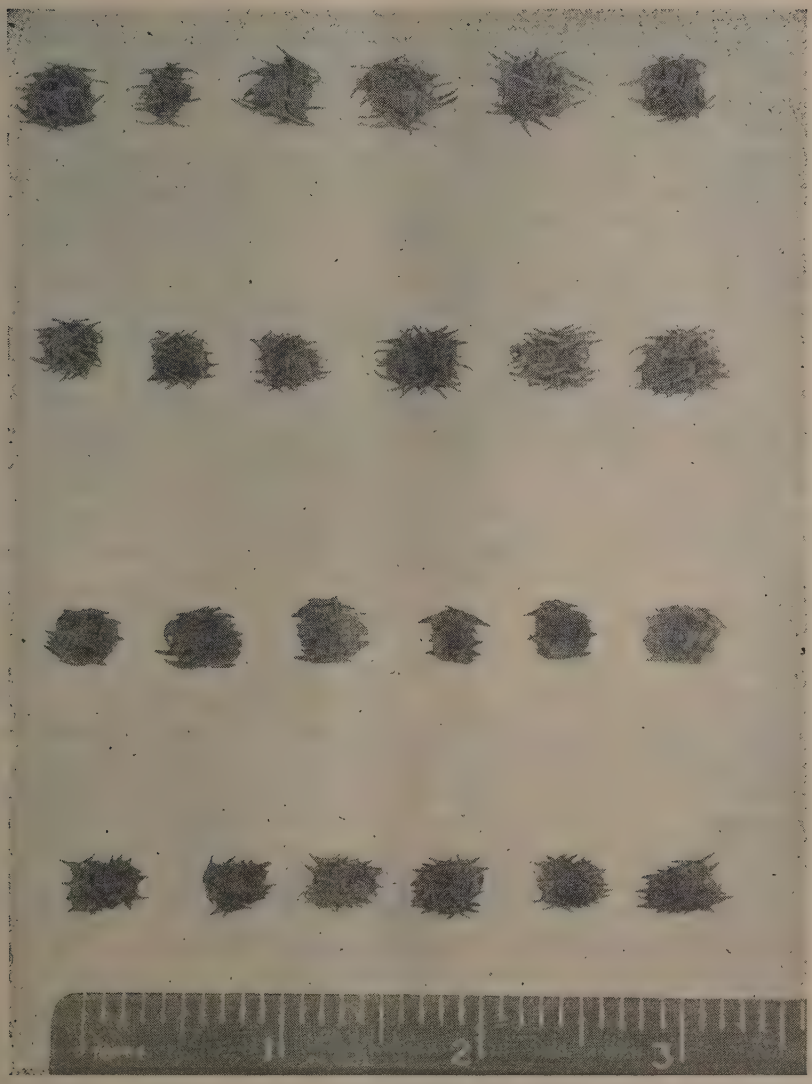

Figure 2.
Two top rows, burrs of M. tribuloides 12725 autotetraploid and diploid. Two bottom rows, M. tribuloides 173 autotetraploid and diploid.

Of the normal plants tested, 23.3 per cent. were classified in the colour range OR2 to R2, whereas 81.1 per cent. of autopolyploids were in this range. None of the normal plants gave the intense red reaction (R2) and 20 per cent. had no apparent cyanogenetic activity (YO). A decided intensification of cyanogenetic activity has been induced by autopolyploidy: a result which is significant statistically. Whether this is due to increased enzyme activity or higher quantities of glucoside cannot be ascertained from these experiments as no attempt was made to use lotaustralin and linamarase solutions as described by Corkill (1940).

Autopolyploidy and Burr Type in M. Tribuloides

In the field there were no apparent differences in vigour between the diploid ($2x = 16$) and autotetraploid ($4x = 32$) plants, but the tetraploids matured 3-4 weeks later than the diploids. Figure 2 shows the differences in burr type between the diploid and autotetraploid of *M. tribuloides* 173 and of *M. tribuloides* 12725. Autopolyploidy resulted in a mean reduction of 20 per cent. in the number of burrs set, although the number of coils per burr and number of mature seeds per burr were similar in autotetraploid and diploid. The mean weight per 100 seeds was increased by 35 and 30 per cent. in the autotetraploids of 173 and 12725, respectively. There were no significant differences between the diploid and tetraploid burrs in length and diameter, or in weight. Autopolyploidy tended to coarsen the burrs and in 12725 there was a 30 per cent. increase in spine length.

It is possible that useful strains of *M. tribuloides* could be developed by induced polyploidy since plants in the C_1 generation varied in type. In 173 and 12725, 38 per cent. and 25 per cent. respectively of the autotetraploids combined superior vegetative vigour and late maturity with normal burr production.

Stem Type, Tiller Production and Fertility in Autotetraploid Wimmera Ryegrass

The 15 selected autopolyploids from the C_0 generation were isolated in a glasshouse and allowed to intercross. The C_1 generation of plants with controls were transplanted in the field in autumn. Root tips of different C_1 plants contained 28 or 14 chromosomes. Tetraploid plants were easily distinguished and percentages of diploids in the progenies of the different C_0 plants varied from 14.4 per cent. to 87.6 per cent. due to sectoring in the original C_0 plants. Different characters were measured in 10 plants of both the diploid and tetraploid and the results obtained are given in Table II.

Autopolyploidy reduced tiller production but resulted in a coarsening of the stems accompanied by an intensification of the purple pigmentation at the nodes, with often a pronounced geniculation as shown in Figure 3. At the end of the season when the diploids were dried off the tetraploids were still producing new green shoots and flowering spikes.

In the tetraploids length of pollen grains was increased by 29 per cent. and width by 56 per cent. Autopolyploidy reduced markedly the percentage of florets forming caryopses.

TABLE II.

Comparison between diploids and autotetraploids of Wimmera ryegrass.

Ploidy	Chromosome No. (Somatic)	Mean tillers per plant	Mean diameter (mms.)		Pollen grains		Percentage of fertile florets
			1st node below head	Internode 1″ below 1st node	Mean length μ	Mean width μ	
Diploid	14	285.4	3.26	2.34	40.6	27.3	68.2
Autotetraploid	28	148.7	4.62	3.18	52.2	42.7	12.5

All results significant at $P < .001$ except those for tillers per plant which are significant at $P < .01$.

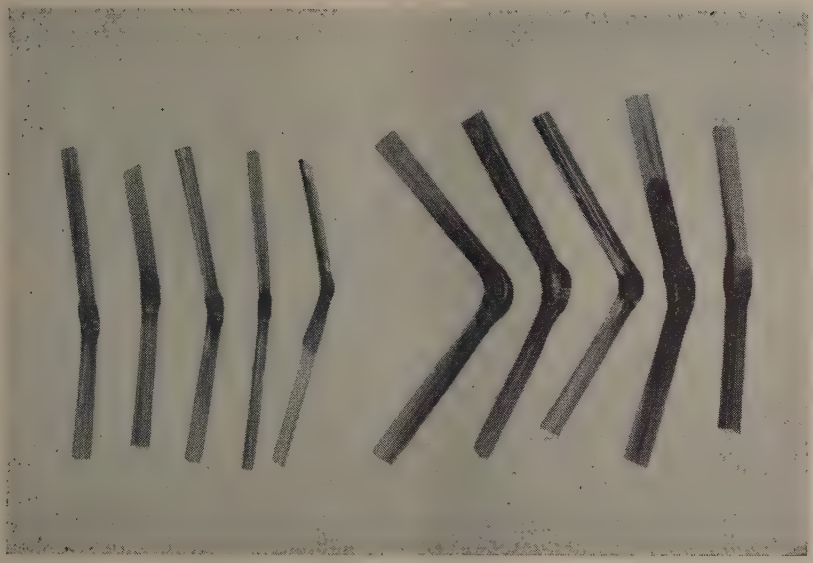

Figure 3.
Diploid Wimmera ryegrass stems on left, auto-tetraploid on right.

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APPOINTMENTS AVAILABLE

COMMONWEALTH OF AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
PLANT FIBRE SECTION
APPOINTMENT OF AGRICULTURAL BIOCHEMIST

Applications are invited for appointment to a position of Agricultural Biochemist with the Organization's Plant Fibre Section located at Highett, near Melbourne, Victoria.

This Section has a team of research officers engaged on studies of various aspects of fodder conservation which is of major importance in the agricultural economy of Australia. The primary object of the work is to reduce the high loss of nutrients associated with current practices. It is now desired to appoint a senior biochemist to extend the work in regard to nitrogen metabolism of forage plants during their conservation as silage or hay. Considerable scope exists for developing new and interesting fields of research.

Applicants should possess an appropriate University honours degree or higher qualifications and have had post-graduate experience in the biochemistry of nitrogenous materials. Acquaintance with modern developments in animal nutrition would be an advantage.

Dependent upon qualifications and experience, commencing salary will be determined within the ranges of Research Officer or Senior Research Officer, £1,313-£1,938 p.a. or £2,048-£2,323 p.a.

In the case of an appointee domiciled overseas, first-class sea fares to Australia will be paid for the appointee, his wife and family.

The appointment will be conditional on a satisfactory medical examination and the successful applicant may be asked to serve for an initial probationary period of up to twelve months before being confirmed in his appointment as an officer of the Organization. If so confirmed he will be required to contribute to and eligible to receive benefits from either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications, quoting reference number 400/75 and stating full name, place, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials, should reach the Officer-in-Charge, Plant Fibre Section, C.S.I.R.O., Graham Road, Highett, Victoria, by 13th September, 1957.

CHANGING CLIMATES AND AGRICULTURE

The publication of an article, "The Climate *Does* Change", in *Rural Research* brings two contributions (Cornish 1954; Deacon 1953) on this topic before a wide public, and especially an agricultural public. It is therefore urgent that their practical significance for agriculture should be discussed. In what follows I intend to show that, with one reservation on the first article, it would be better for agriculturists to pay little attention to claims of changes in rainfall. I am not dealing with meteorological theory in what follows, but with the relation of figures to agricultural practice. It is of some interest, moreover, to note that on one important matter the two pieces of work contradict one another.

Cycles in Adelaide.

Dr. Cornish is quoted as showing that the "start of the winter rains" in Adelaide has fluctuated in 23-year cycles, of which five are shown (the fourth being poorly marked); the fluctuations amount to 30 days from the earliest to the latest, separated by an interval of eleven years. The date of break of season in autumn in South Australia is very important. However, this is not what Dr. Cornish has calculated or plotted. The cycle was obtained, according to *Rural Research*, from the date at which one-fourth of the year's rain had fallen.* This is a strange criterion for an agriculturist, since it does not mention the actual rainfall in April-June. Heavy rain in February would make the date early, and heavy rain in the subsequent October-December would make it late. The years 1946 and 1936 respectively had these opposite features, yet their *agricultural* rain from April to July was closely similar. Many of the years shown as having an early break merely had heavy rain in January and February, most of which would have been agriculturally useless. Incidentally, the curves as published have been severely smoothed. The year 1889 had the heaviest January-April rain on record and had had nearly one-third of its rain by the end of April, but it appears on the graph as having a late break because neighbouring years had dry summers and autumns, notably the preceding year 1888, with the smallest January-April rain on record. This is a warning to the reader, rather than a criticism of the author. One should interpret the curves as meaning, at the maximum, "Most years hereabouts had had one-fourth of their rain early", and at the minimum "Most years hereabouts had had one-fourth of their rain late".

The main achievement in Dr. Cornish's study can be most clearly expressed for the agriculturist in terms of the *total* January-April rain. His years with "early" rain are clustered around 1856, 1878, 1901, 1923, and 1944, and those with "late" rain are clustered around 1843, 1867, 1889, 1913, and 1933; 1955 should be the next in the sequence, and is included in what follows. If we consult simply the monthly records of Adelaide's rainfall, and count the seven years centred on each of those quoted, for example take 1856 as standing for 1853-9, we find that out of each set of seven in the first, "early" group, January-April rain exceeded five inches in 5, 4, 4, 2, and 4 years (totalling 19 out of 35 years) while in the second, "late" group it exceeded five inches in 2, 0, 1, 0, 2, and 2 years (totalling 7 out of 41 years—the 1955 set is still incomplete).

*This is not strictly accurate, since the "years" used are not identical with calendar years; but they are so nearly identical that we can accept the interpretation in *Rural Research* without either harming or benefiting the original thesis.

This contrast is remarkable, but it does not tell us anything about winter rains, and has no obvious agricultural implication. The April-May figure is more relevant. If we count the number of years in each set of seven with over four inches in April and May, we get for the "early" group 6, 5, 5, 5, and 3 (totalling 24 out of the 35 years) and for the "late" group 3, 2, 3, 2, 3, and 4 (totalling 17 out of 41 years). Perhaps this result might pass a statistical test, though it is a slender basis for taking action. It is the most favourable example which I could find in defence of a theory of agriculturally important cycles. It is the "late" group which is exceptional here, if it is in fact exceptional. Four inches in April-May is recorded in 60 per cent. of all years.

A minor theme in the same article is that the average date at which seven-eighths of the year's rain has fallen has become later since records began. This is expressed in the words that "spring rains occur three weeks later". This gives the impression that the spring season is prolonged for three weeks—which would be most important if true, but which does not appear to be true, and which was perhaps not intended. Whatever may be the significance of this calculation to meteorological theory, it is very difficult to find any meaning for it in agricultural practice. If one consults the records for the rainfall during the last three months of the year, the only feature that favours the theory of a change in climate is that seven years out of nine in 1944-52 had over 5 inches of rain in October-December, while only 30 years since 1839 had such a high total. The odds against such a coincidence must be high, but it would be unwise to draw any conclusion of agricultural importance about a trend, especially since years with a very *dry* ending (less than 2 inches in October-December) have been more frequent in the last forty years than during last century, 1938 being the latest example.

Progressive Trends in South East Australia.

Mr. Deacon's article concerns the summers in south-eastern Australia from 1911 onwards. Both the original and the popularized article deal with temperature as well as rainfall, but only rainfall will be dealt with here. The theme of this article is that summer rainfall has increased especially around Adelaide and in western Victoria away from the coast—that is, in that part of south-eastern Australia where the summer is normally dry.

The calculations in this study were concentrated on two periods, namely 1881-1910 and 1911-1940, and the months chosen for study were December, January, and February. Increases in the total rain in these three months reach 44 per cent. in Adelaide and 30 per cent. in western Victoria. Both of these choices—of years and of months—can be shown to have been unfortunate.

The first year of reference, 1881, was understandably chosen because earlier records were incomplete. However, there were several unusually dry summers in the 1880's and there had been several wet summers in the 1870's, so that this choice gives too low a base-line for reference. Secondly, in western Victoria (though not in Adelaide) February 1911 was extraordinarily wet. Now as Deacon states, his effect is shown far more by February than by the other two months; and if a line is drawn after 1911 instead of 1910 the percentage increase of the Februaries drops to a low figure.

But a major objection is to the choice of December, January, and February for the calculation. The first half of March belongs to summer more than does the first half of December; it matters little whether an erratic monsoonal storm comes in late February or early March. If we choose to make our "summer" the months of January, February, and March instead of December, January, and February, we get a very different story.

(a) In *Adelaide* we have already seen that heavy rainfall during the early months of the year occurred more frequently around such years as 1901, 1923, and 1944 than at other times. The cyclic tendency worked on by Cornish is incompatible with Deacon's view of a trend towards heavier rainfall, and in fact the January-March rainfall in Adelaide, like the January-April, has often been relatively heavy in these sets of years. If we tabulate the January-March rain by successive decades we get the following numbers of inches, starting with 1841-50; 18, 27, 21, 33, 21, 23, 26, 24, 28, 30, and 30. The increase of 1911-40 over 1881-1910 is now only 17 per cent.; if we had included in our basic period the preceding decade of 1871-80 with 33 inches, the increase would have been only 6 per cent. The whole affair now appears trivial. Deacon noticed that the Februaries were most responsible for his relative increase, but apparently did not think of balancing that highly erratic month with its equally erratic neighbour.

It might still be argued that December should be incorporated with January, February, and March, though probably mid-December to mid-March would be best of all. The result of working with the December-March figures is that the increase of 1911-40 over 1881-1910 now equals 28 per cent., and the increase over 1871-1910 is 15 per cent. These figures should be considered in conjunction with those that follow.

(b) In *Western Victoria* the tendency for years with summer rain to cluster around the dates noted by Cornish for Adelaide cannot be traced, and distribution should be expected to be random. One can understand this difference without entering into expert meteorology. If Adelaide's summer rain came predominantly from one source only and Western Victoria's from two or more, that would account for the randomness of the latter. If we take the figures for Stawell, with an average annual rainfall of 21 inches (the same as Adelaide's) and take the rain for December-February, we find a percentage increase of 1911-1940 over 1881-1910 of 25 per cent., in accordance with Deacon's work. However, almost half this increase is represented by the single month of February 1911. If we drew our dividing line one year later, at 1911 instead of 1910, the percentage increase of 1912-41 over 1882-1911 would be only 3 per cent. If we took January-March instead of December-February the effect would be similarly trivial without even tinkering with the boundary line, while if we then extended our basis of reference back to include the decade 1871-80 there would actually be a *decrease* in 1911-1940. The whole case for a changing climate must therefore rest on the decade 1941-50. The successive decades for December-February, starting from the summer of 1870-71, give the following number of inches: 34, 32, 30, 26, 41, 34, 35, and 43. The two decades with over 40 inches are 1911-20 (which includes one year with 11½ inches, already mentioned) and 1941-50 (which includes the exceptional season of 1946, with 8½ inches). For nine years out of each of these ten the mean was respectively no more than 3.3 and 3.8 inches.

An Alternative Analysis

It should be clear from these trivial conclusions that one should not use averages, which can be distorted by one or two freaks of rain coming at a normally dry time. One should rather look for the frequency of years with heavy falls (as in the above illustrations of Cornish's work), or analyse the records as follows.

A simple check of the popular doctrines of changing climates and of tendencies to dry or wet spells has already been described in this journal (Leeper 1953). This consists of first finding the median rainfall and so describing every year as either wet or dry. The numbers of spells of two, three, four, or more wet or dry years running are then compared with what one should expect with tossing a penny. For example, in a period of 80 years one should expect to find 52 per cent. of all

years occurring as singles or pairs, 29 per cent. as runs of 4 or more, 16 per cent. as runs of 5 or more. (The formula, given by Hald (1952) relies on a theory of permutations and gives similar results to a simpler one used by Alexander (1957). Few people realize how great is this natural tendency towards runs.

In every case in which this test has been applied in south-eastern Australia, whether to whole years or to seasons, the result has been that runs occur just as one should expect from tossing a penny.* A simple way to check this is to count the total number of runs in the record and divide it into the number of years. The quotient should ideally be 2. If it is more, this indicates a long cycle or a trend; if it is less, it indicates a two-year cycle—a tendency for a dry year to be immediately compensated by a wet one. In fact, it is commonly close to 2. It is more likely than not that a spell of 7 successive years above or below the median will occur in 100 years. When such a thing happens it does not follow that the climate is changing,

This last test is probably the correct one in general for an agriculturist. Each year is a new one, and the main interest is whether the year (or the season) will be wetter or drier than the median; the answer is simply a toss-up. But the test is not very sensitive. In general this is not a drawback, since we are seldom interested in effects that need sensitive tests for demonstration. It would, however, have concealed the relation discussed above for the rainfall of the early months in Adelaide, namely that years with substantial rain in January-April tend to cluster around a centre, of which 1944 was the latest example. These years with early rain do not occur as runs, but are scattered at random among a set of seven which might include one or two that are very dry. They do not, therefore, impose themselves on the general pattern of runs.

Finally, while my conclusion is that practically nothing can be said about trends or cycles in most of our climates and that we should reject equally the gambler's belief in good or bad runs and the cancelling of good luck by bad luck, I do not want to detract from the remarkable achievement of Cornish in isolating a peculiar feature in the climate of Adelaide.

*The apparent tendency to runs of 2, remarked on in the earlier note, has not been observed in this part of Australia, and may not be significant anywhere.

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ARE THERE CLIMATIC CYCLES? — MELBOURNE'S RAINFALL EXAMINED

The year 1957 is apparently going to end the long run of years in Victoria with rainfall above average. The intriguing problem of whether such runs may be ascribed to chance was considered by Professor Leeper in 1952, (Leeper 1953), who stated that "spells of three years or more are not more frequent than should be expected by chance". In view of the wet regime since then, and the findings of C.S.I.R.O. who sponsor the thesis "Climate does Change" (Anon. 1957), it is worth while re-examining this problem. The exact solution to the problem of runs in a finite sequence of years is complex, (it appears to have "stumped the experts"

in N. G. Neare's Column in Civil Engineering) (Neare 1957); hence we will base the analysis on an unlimited sequence being much simpler and sufficiently accurate, using 101 years, the available record for Melbourne.

The question has a number of practical applications. For example, the future natural behaviour of Lake Corangamite, upon which it is mooted that about half a million be spent to alleviate flooding, is obviously dependent upon rainfall in the years to come. Although we cannot forecast actual rainfalls, we can estimate the probabilities of receiving specified average rainfalls if the sequence of years is random, and hence study the probable behaviour of the Lake. If such sequences are not due to chance, the basic assumption of randomness no longer holds.

There is an official continuous record of rainfall in Melbourne since 1855, and eleven years of records from 1841 to 1851 inclusive, but no known records—official or otherwise—for the early fifties. To test for runs we need a continuous record, and consequently will examine the 101 years from 1856.

For this period the average annual rainfall is 26.0 in. with a median or middle value of 25.8 in. As half the rainfalls are above 25.8 in. and half below, the chance or probability of any one year being above 25.8 in. is a half. If we designate such a year as "a" and one below 25.8 in. as "b", we have a sequence of a's and b's which can be examined for "runs". The length "r" of a's (or b's) is here defined as equal to the number of a's (or b's) in succession, with a change from a to b at both ends of the run. The number of runs of either kind from one to eight years is given in Columns 4 and 5 in Table I.

As runs of a's and b's alternate, the number of runs of a's will be equal to , or differ by only one, from the number of runs of b's, but the *total* number of runs for a given sample size may differ from sample to sample. If there is "persistence" —to use the accepted climatological term, the total number of runs will normally be less than if the sequence of a's and b's is entirely random, i.e. the annual rainfalls are not correlated. Tests for randomness have therefore been devised by comparing the observed and expected number of runs (Hoel 1954).

For a random sequence the probability of a run being ended is $\frac{1}{2}$ and consequently for an infinite sequence—or its equivalent, a "circular" sequence obtained by joining the tail to the head of the series—the

TABLE I.

Length	Theoretical Distribution of Runs		No. of Runs in 101 years.			
	Prob.	Return	Observed O_r			Expected E_r
r	Pr	Period	a	b	a & b	a & b
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	½	4	12	14	26	25.8
2	¼	8	9	2	11	12.9
3	⅛	16	4	4	8	6.4
4	1/16	32	—	4	4	3.2
5	1/32	64	—	1	1	1.6
6	1/64	128	—	—	—	0.8
7	1/128	256	—	—	—	0.4
8	1/256	256	1	—	1	0.4
>8	1/256		—	—	—	
Totals	1		26	25	51	51.5

expected number of runs in "n" years is equal to $\frac{n}{2}$, the average length of run therefore being two years. For the finite case, the expected number of runs has to be increased by one because of the "end" effects. Thus for the finite sequence of 101 years, the expected number of runs is $51\frac{1}{2}$, which is so close to the 51 observed that there is no justification from this criterion for assuming anything but a random sequence.

We will next examine Table I in more detail by comparing the expected and observed numbers of runs of different lengths, in particular the run of 8 years to 1956, which is as yet incomplete.

In an infinite sequence of years, the probability Pr of a run of r years of either a's or b's in succession is $(\frac{1}{2})^r$, as shown in Column (2). The probability of a run of length *greater* than r is, by definition, the difference between "certainty", i.e. a probability of one, and the sum of the probabilities of runs of length 1 to r. From the Table, this probability is also equal to $(\frac{1}{2})^r$. Hence the probability of a run of r or more years is equal to the sum of the respective probabilities or $(\frac{1}{2})^{r-1}$.

To obtain the expected number of runs E_r of length r, its probability must be multiplied by the total number of runs expected, namely $51\frac{1}{2}$ in a finite sequence of 101 years. The probabilities given in the Table assume an infinite sequence, but comparison of these values with those for a finite sequence shows that the differences are negligible in this example. Comparison of the expected and observed number of runs in Columns (6) and (7) shows that the differences are small, again suggesting the sequence of years is random.

The observed run of 8 may be considered further by introducing the convenient, though not essential concept of the "return period". The return period is here defined as the number of years between occurrences of a specified event. As stated above the probability of a run of r or more years is $(\frac{1}{2})^{r-1}$, or once in 2^{r-1} *runs;* but the average length of run is 2 years, hence the *expected* return period for this event is 2^r years. For 8 or more years the expected return period will be 256 years, Column (3). As the event of 8 or more a's or b's in succession has occurred only once in 101 years, it has an *observed* return period of 101 years.

The probability of *at least* one run of 8 years or more in a continuous record of 101 years may be readily obtained from the statistical distribution of the return period which is known to be exponential (Feller 1950). This probability is given by $P = 1 - e^{-m}$ where m equals the ratio of the observed return period (101 years) to the expected return period (256 years) and e is the exponential constant and equals 2.72. Hence P = 33%, which by itself is too high to vitiate the hypothesis of sequential randomness.

If we are to obtain further *independent* data normally required for testing such hypotheses, it is necessary to avoid stations whose annual rainfalls are correlated with Melbourne, such as Adelaide. Combining the records of these two stations would reduce sampling fluctuations, but not add proportionately to the length of record. If these spatial correlations of climatic indices, such as annual rainfalls, are caused by extra-terrestrial effects having a world-wide influence, the number of independent stations is extremely small. Time alone may allow this basic problem of trends to be solved; at the moment it is advisable not to be too dogmatic on the subject.

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HOST RANGE OF THE SUGAR CANE RATOON STUNTING DISEASE VIRUS

Ratoon stunting disease of sugar cane (Hughes and Steindl 1955) was first recorded in Queensland, and has since been recognised in practically all cane growing countries of the world. This disease causes severe losses in yield without producing any external diagnostic symptoms in the cane plant, the only satisfactory method of diagnosing the disease at present being by a reddish discolouration within the nodal tissues of certain infected varieties.

Apart from the economic aspects, alternative hosts of ratoon stunting disease could be of importance in diagnosis if they produced characteristic symptoms when inoculated. Inoculations were therefore made into a large range of plants in the hope that a suitable indicator might be found.

Earlier work (Steindl 1955) showed that maize, sorghum and sweet sudan grass could be infected with the disease without exhibiting any symptoms. More recently a number of other grasses were also artificially infected with the disease, but they too showed no observable effects although the disease was easily transmitted from them back to the susceptible sugar-cane variety Q.28. These grasses include:

Brachiaria miliiformis (Presl.) Chase	Green summer grass
Brachiaria mutica (Forsk) Stapf	Para grass
Chloris gayana Kunth.	Rhodes grass
Cynodon dactylon (L.) Pers.	Couch grass
Echinochloa colonum (L.) Link	Barnyard grass
Imperata cylindrica (L.) Beauv.	Blady grass
Panicum maximum Jacq.	Guinea grass
Rhynchelytrum repens (Willd.) C. E. Hubbard	Red Natal grass
Sorghum verticilliflorum Stapf.	Wild sorghum
Sporobolus capensis (Willd.) Kunth.	Parramatta grass

Several other grasses and cereal crops, as well as a number of dicotyledons commonly used as virus indicator plants, were also tested, but none has become infected with the virus.

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CHANGES IN THE THICKNESS, WEIGHT AND PROTEIN CONTENT OF THE SKIN OF TWO ADULT MERINO EWES

Introduction

The capacity of the animal body to store dispensable protein has been clearly shown. Under subsequent nutritional stress this protein is catabolisable (Kosterlitz and Campbell 1945). Addis, Poo and Lew (1936) have described a skin protein loss in fasted rats. Dowling (1945) has reported changes in the skin thickness of Shorthorn cattle attributable to differences in nutritional plane. There would appear to be no similar observations recorded for Merino sheep.

Measurable changes in thickness, weight

or protein content of the skin may adequately reflect changes in nutrition and thus provide a useful measure of the incidence and magnitude of seasonal nutritional stresses which commonly occur under grazing conditions. Preliminary observations are reported.

Experimental

(a) *Method.*—Two unmated, four tooth Merino ewes were selected for similarity in body weight, wool type, and skin histology. The skin sampling area was delineated as a 24 cm^2 tattooed "chessboard" on the midside and the sites randomised as a 6 x 6 Latin square. Skin samples (6) were taken from appropriate shaven areas at two monthly intervals using a 1 cm diameter skin biopsy punch. The thickness of each fresh section was measured with a micrometer, its oven dry weight (100°C.) and finally nitrogen were determined (micro-Kjeldahl). Wool production and skin area change was measured from a 10 cm^2 midside patch tattooed on the opposite side.

(b) *Diets.*—Ewe No. 126 was grazed for twelve months on average pasture. Typical seasonal changes in wool production and bodyweight were recorded. Climate in this area is Mediterranean with a predominantly winter rainfall followed by a summer drought. Grazing intake studies (to be reported elsewhere) have shown that the resulting wide seasonal differences in protein intake largely control productivity.

Ewe No. 152 was pen fed a restricted ration of wheaten chaff and oats. This animal lost bodyweight rapidly and was slaughtered after 250 days.

Observations were thus recorded under a wide range of dietary regimes.

Results and Discussion

The skin of these Merinos consisted largely of protein (mean N x 6.25 = 84.5% as dry matter). Thus high correlations were to be expected between the three measurements (Table I).

These coefficients are based upon all individual samples for which observations were complete, viz., sixty-three. Complete results for nine skin samples were lost in analysis for nitrogen.

TABLE I.

Total correlation coefficients.

Thickness (mms) : Weight (mgms D.M.)	+ 0.843*
Thickness (mms) : Nitrogen (mgms)	+ 0.826*
Weight (mgms D.M.) : Nitrogen (mgms)	+ 0.944*

*Significant at 0.1% level.

Large percentage changes were recorded for the mean skin measurements of each sampling time. Trends are similar for each measurement and they are generally related to changes in bodyweight and skin area measurements (Figure 1). Changes in skin measurements are expressed as a percentage of their values on 14/9/55 (zero days) and changes in patch area as a percentage of their values on 16/1/55. The mean absolute values of these initial measurements are given in Table II.

TABLE II.

Mean absolute values of initial skin measurements.

Skin Samples*	No. 126	No. 152
Thickness . ..	1.98 mm	1.88 mm
Nitrogen	3.06 mgm	2.98 mgm
Dry weight . ..	25.2 mgm	22.2 mgm
Body weight ..	37.2 kg	39.2 kg
Patch Area†		
Relaxed	97.6 cm^2	88.1 cm^2
Stretched . ..	114.0 cm^2	105.5 cm^2

*On 14/9/1955 (zero days).
†On 16/1/1955.

Variation in the whole skin will be proportional to the product of area and the third dimensional measurement of choice. The general picture emerges that the Merino skin varies markedly in size with plane of nutrition and that the thickness dimension plays the largest part in these changes.

The implication of this finding may be of some importance in wool biology studies

where it has become common practice to express wool growth in terms of unit skin area production. Since the skin is the wool producing organ it may be more proper in some circumstances to breakdown total productivity into the product of skin weight and production per unit weight.

The linear regression of N x 6.25 content (Y) on changing dry weight (X) for the means of each sampling has been calculated (Figure 2). The regression coefficient (+ .9412) shows that almost all of the weight changes can be accounted for by increased or decreased skin protein content. This provides clear evidence that the skin of the adult Merino is capable of storing nitrogen which is subsequently catabolisable.

Although precise measurement of dietary intake and its efficiency of utilisation is lacking for ewe No. 126, it would appear likely that the nutritional stress encountered was largely protein insufficiency (see Experimental). Under grazing conditions the onset and extent of the negative nitrogen balance which undoubtedly occurs in the summer-autumn drought period may well be reflected by this measurement of skin protein catabolism. However, before it can be decided whether or not skin biopsy is useful in studies of animal-pasture inter-relationships in this environment further critical information is needed on:—

(a) The capacity of other organs of the Merino to store protein and the

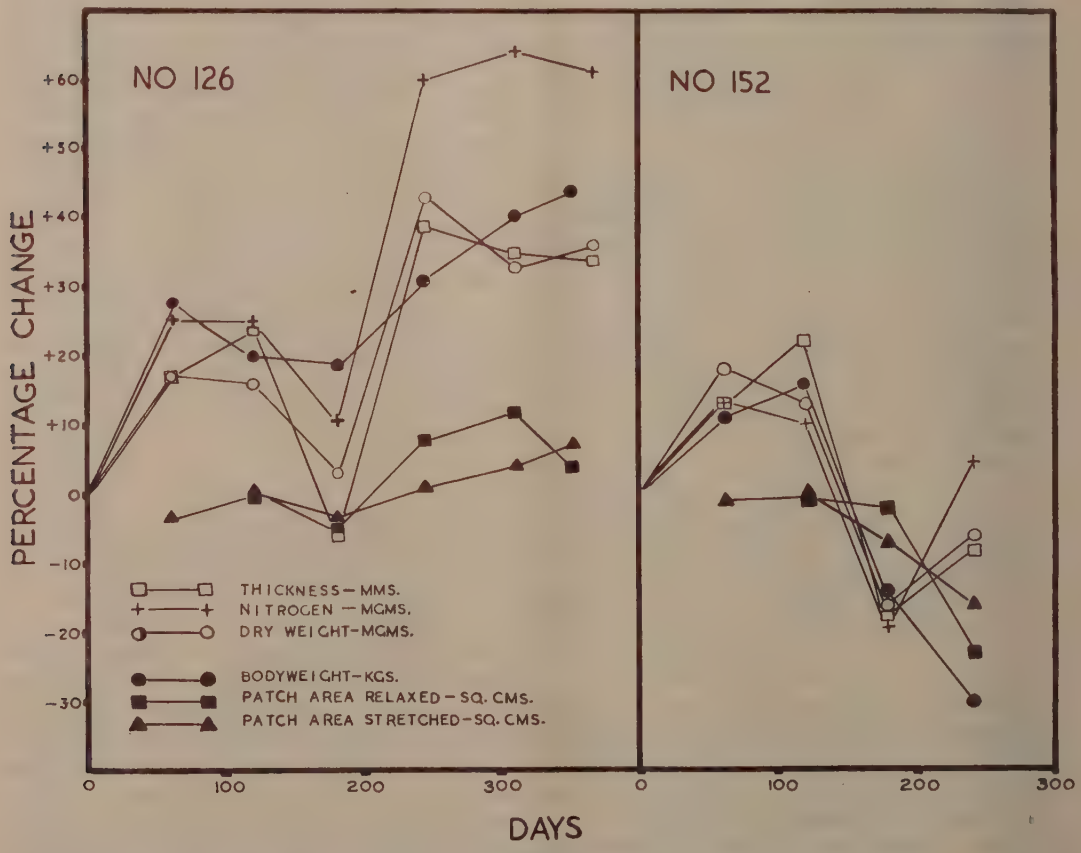

Figure 1.
Percentage changes in midside skin measurements and bodyweight.

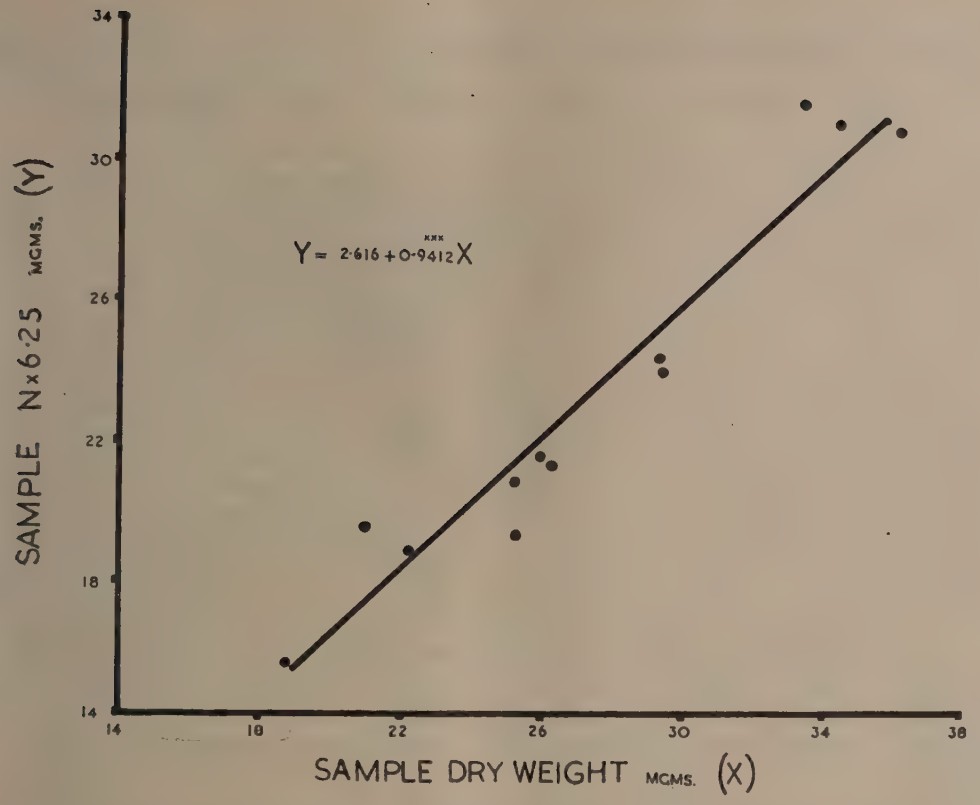

Figure 2.
The regression between the mean values of Nx6.25 (mgms) and dry weight (mgms) at each sampling period for both ewes.
Significant at 0.1% level.

priority of such dispensable protein in catabolism.

(b) The effect of energy insufficiently on skin protein loss.

The period of nitrogen loss from the skin of No. 126 occurred in the summer drought period between January and March. The mean loss was 0.44 milligrams per skin sample. By employing an empirical relationship of surface area to bodyweight, viz., Area (metres^2) = $0.117W^{0.59}$ (Kilos.) (Marston 1948), which has been used for South Australian Merinos, a tentative figure for total catabolic loss from the whole skin can be calculated. This figure is 6.2 grams of nitrogen for an eight week period. Since even larger amounts can be expected from other organs, the extent of protein storage in the adult Merino and its influence on nitrogen transactions would appear worthy of detailed investigation.

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2,3,4-TRICHLOROPHENOXYACETIC ACID AS A SPRAY TO REPLACE CINCTURING OF CURRANTS

Experiments have been carried out over the past decade in a number of countries to find a growth regulator spray which could be used as a substitute for cincturing of the currant (*Vitis vinifera* var.), and it has been shown that parachlorophenoxyacetic acid (PCPA) and 2,4-dichlorophenoxyacetic acid can be used for this purpose. However both these substances have side effects, and concentration and rate of application have to be carefully controlled to avoid serious damage to the vines.

A new approach to the problem was suggested by the results of Day and Erickson (1954) who found that 2,3,4- and 2,3,5-trichlorophenoxyacetic acids were active in preventing the abscission of lemon leaves. Leaper and Bishop (1951) had previously shown that these substances have little or no rooting, cell elongation, or formative activity on tomatoes. It seemed possible that they might have the properties necessary to replace cincturing of currants without any undesirable side effects.

A trial was commenced in spring 1956 using samples of the sodium salts of 2,3,4-T and also 2,3,6-T and 2,4,6-T, which were readily available, kindly supplied by Timbrol Ltd., Sydney. Each substance was applied at four concentrations (100, 40, 16 and 6.4 p.p.m.) to single vines, each treatment being replicated five times. The sprays were applied with a knapsack sprayer on November 26 and 27 when the bunches were at the stage recommended for PCPA spraying. Following heavy rain on February 6 and 7, 1957, the fruit was badly damaged and had to be harvested earlier than intended. The bunches were picked and weighed singly to obtain the mean bunch weight per vine, and each bunch sampled to give a representative sample of berries for a sugar determination for each vine. The vines treated with the two higher concentrations of each substance were all harvested, but to avoid delaying the harvest only vines receiving 2,3,4-T in the lower concentrations were harvested since it was early aparent that this was the only effective substance.

The results are shown in Table I. The effect of 2,3,4-T is quite obvious from the table. Bunch weight was greater by almost half and sugar content less by one sixth on the vines treated with this substance. Statistical analysis showed that the difference between 2,3,4-T and the other substances in both bunch weight and sugar content far surpassed the 0.1 per cent. level of significance while the differences between the two concentrations of 2,3,4-T and between the other substances or their concentrations were not

TABLE I.

Bunch weight and sugar content for currant vines sprayed with some trichlorophenoxyacetic acids.

	Concentration	2,4,6-T	2,3,6-T	2,3,4-T
Bunch wt. (g)	100 p.p.m.	128.8	104.7	169.7
	40 p.p.m.	114.0	117.5	171.1
Sugar content (°Brix)	100 p.p.m.	27.4	27.6	22.1
	40 p.p.m.	27.3	27.6	23.6

significant. Results for the two weaker concentrations of 2,3,4-T suggested that 16 p.p.m. was less effective than 100 or 40 p.p.m. although still showing some effect, while 6.4 p.p.m. was ineffective.

The effect of 2,3,4-T was also evident in the appearance of the fruit. The berries were larger and their colouring less advanced than those from the other treatments, which showed the characteristic appearance of untreated fruit. Coombe (1950) found that fruit treated with 2,4,6-T at 75 p.p.m. did not differ from untreated fruit.

Through the great kindness of Dr. J. M. F. Leaper of the American Chemical Paint Co., U.S.A., a small sample of the sodium salt of 2,3,5-trichlorophenoxyacetic acid was also tested. The same concentrations were used as for the other substances but only one vine was sprayed with each concentration. The indication was that 2,3,5-T did have some effect but it was less than 2,3,4-T at the same concentration. This agrees with Day and Erickson's findings of the relative effectiveness of these two substances in preventing the abscission of lemon leaves.

None of the substances at any of the concentrations tested showed any formative effects on the vines whatsoever. 2,3,5-T is very difficult to prepare and for this reason is unlikely to be used commercially, but this should not apply to 2,3,4-T. 2,3,4-T therefore appears to be a very promising substance for a spray to replace cincturing of currants.

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CONTROL OF BRACKEN FERN BY WEEDICIDES

Introduction

In the Strzelecki Ranges of South Gippsland, the Forests Commission of Victoria is undertaking the reforestation of extensive areas, originally cleared for farming, but which have now been abandoned and have reverted to the Crown. One of the main difficulties in reforesting these areas is to prevent suppression of the planted stock by the prolific growth of bracken fern. Liberation treatments, that is cutting the bracken fern for a two to three foot radius around the plant, are necessary and frequently cost £5 to £10 per acre. With a potential area of over 200,000 acres to plant this represents one of the major costs in reforestation.

Trials to determine the effectiveness of some selective and total weedicides were commenced in 1952 and 1953 and completed in 1956. However, as with most previous investigators (Ahlgren, Wolf and Klingman 1951; Alcock and Braid 1928; Braid 1940, 1947; Barnett 1931; Bache Wiig 1940; Davies and Davies 1950; Gregor 1932) results were generally negative.

Experimental Design

Prior to treatment random check counts showed that bracken density and height were relatively uniform within the area of each trial, although some differences occurred between the various test areas. Mean height ranged from 30 in. to 42 in. and density of fronds from 4 to 6 per square foot of which rarely more than two were green fronds. So as to ensure adequate fresh growth for treatment, all

old bracken was cut and removed from the test area in the 1952 series and burnt off in the 1953 series.

The selective weedicides were included as possibilities for post-planting liberation and the total weedicides ("Ammate" and sodium chlorate) for pre-planting spot spraying.

Weedicides tested were 2,4-D (ethyl ester) and 2,4,5-T (butoxy ethanol ester) at 1, 5, 10 and 15 pounds, 2,4-D and 2,4,5-T at 1% and 3% by volume in dieselene at 50 gallons per acre, "Ammate" at 100, 200 and 500 pounds, T.C.A. at 20, 60 and 100 pounds, I.P.P.C. at 2, 4 and 6 pounds (applied as a dust), maleic hydrazide at 1 and 4 pounds, and sodium chlorate at 1½ and 3 cwts. Except where indicated all rates are pounds per acre of active ingredients, and were applied in water at 100 gallons per acre.

Five stages of growth were tested, viz. crozier, petiole extension under way but not completed, petiole fully extended with lamina still rolled, lamina unrolled but frond still a light green colour, frond mature and "hardened off." Application at three different times of day (11 a.m., 3 p.m., and 7 p.m.) was also investigated.

Split plot designs were used in the preliminary trials, and randomised blocks in the more critical "follow up" trials. Plots were 6′ x 6′, later 4′ x 4′, with a 3′ buffer strip around each plot. A total of 509 plots was established.

Treatments were carried out in November to January 1952 and 1953. Measurements were made approximately twelve months later, i.e., after the spring regrowth, indices of measurement being total height and number of fronds per plot. Trials were substantially concluded in December 1954, although observations were continued until July 1956.

Results and Discussion

Most of the weedicides used had some effect on the fronds on the plot at the time of spraying but this can be achieved with a wide range of weedicides other than those tested. All results refer, therefore, to the regrowth following treatment, i.e., the position approximately twelve months after treatment. They also generally refer to changes in the number of fronds, as in no case was any reduction in height attributable to the treatments observed.

(a) *Weather Conditions*

Although detailed records of rainfall, temperature, humidity, wind and cloud at the time of treatment were kept, there was no evidence to show that weather conditions at the time of treatment had any effect on the regrowth.

(b) *Time of Day*

This factor was investigated as, while the exact mode of translocation of selective weedicides is not fully understood, it is believed to be in conjunction with elaborated food products. Consequently toxicity could be affected by photosynthetic activity.

However, in no case was time of day shown to be significant.

(c) *Stage of Growth*

Generally best results were obtained when the lamina had unrolled fully and hardened off to some degree, but even so results were very variable and significant in only a few cases.

Although the individual fronds are more resistant at this stage the lack of significant results at the younger stages (e.g., crozier, or with petiole extended but lamina still rolled) is probably due to the emergence of some fronds after spraying; consequently they were not treated and so there was no opportunity for translocation of the weedicide.

(d) *Weedicides and Levels*

(i) *2,4-D*—low and medium levels had no effect, while at 15 pounds per acre some reduction in the number of fronds was achieved at the mature stage. (Control mean number of fronds per plot was 26.1, treatment 15.6, 1% significant difference 8.9.) At this level however 2,4-D is no longer selective and acts as a total weedicide.

(ii) *2,4,5-T*—low and medium levels had no effect; high level in a few cases had some effect, but it was very variable

and not pronounced. Results were not significant.

(iii) *2,4-D and 2,4,5-T in dieselene.* Some reduction achieved when applied to the mature foliage but since equivalent levels applied in water had no effect the results are probably due more to the dieselene than 2,4-D or 2,4,5-T. However the level of dieselene required is uneconomic, considering that partial and temporary control only is obtained.

(iv) *I.P.P.C. and Maleic hydrazide*—no effect apparent.

(v) *Sodium chlorate at 1½ cwt per acre* had no effect, but at 3 cwt per acre there was a considerable reduction in the number and vigour of the fronds at all stages of growth. Control mean number of fronds per plot was 38.1, treatment means 18.5, 1% significant difference 10.3. Equivalent figures for application at the mature stage were control 39.2, treatment 11.0, 1% significant difference 11.8.

1956 Observations

As indicated the results given above refer to the position approximately twelve months after treatment. During July 1956 all the plots (established 1952 and 1953) were re-examined but no differences were observed between controls and any of the treated plots.

Any effects of any treatment apparent in 1953 or 1954 had therefore disappeared within three years of the original treatment. It appears, then, that any degree of control which could be obtained could not be expected to last for more than probably one season. This would be of no real practical value in liberation treatments.

Economics

Considering that at the best partial and temporary control only was obtained, levels of any of the weedicides which had any effect are so high as to be quite uneconomical under present conditions. Moreover, control is far from complete and the levels required are toxic to the planted stock, so no results of any assistance in normal liberation operations were obtained.

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THE MOISTURE STATUS AND SALINITY OF SOILS OF THE FLYING FOX FAMILY AT ANGASTON, S.A.

During the soil survey of the Angaston-Springton area of the Barossa District, S.A., it was observed that areas defined as the Flying Fox family of skeletal soils and their intergrades with the Hutton Vale family of red podzolic (?) soils, had numerous small and irregular bare patches of soil, one to two yards across, alternating with small grassed areas, so that the land surface presented a pock-marked

appearance. Further details of this occurrence and aspects of its land use are discussed by Northcote and de Mooy (in press).

The sharp boundary between the grassed and ungrassed areas suggested that the problem was one associated with moisture and salinity. Accordingly in January 1955 a sample of the surface soil (0-1 in.) from one of the bare patches was examined and found to contain chloride equivalent to 0.88 per cent. NaCl* whereas a sample from a nearby grassed area contained 0.01 per cent. NaCl. To obtain further information on salt and moisture content, two fresh sites not more than 2 yards apart were sampled at the end of June 1955, 15-16 in. of rain having fallen since the earlier sampling. One site was covered mainly with native perennial grass species and sampled to a depth of 45 in.; the other was a bare area which was sampled to 19 in. Such bare sites being notable for the compact state of the surface soil in contrast to the mellow condition of the grassed areas. Both sites represented intergrades between the skeletal and red podzolic (?) soils. The results of analyses for salt and moisture are set out in Table I.

It is apparent from the data of Table I that only a very small amount of water has entered the soil at site 2 for the horizon of maximum salt concentration has only moved from 0-1 in. in the summer to 1-4 in. Practically no water has penetrated below 4 in. for the moisture content below this depth is identical with the wilting point. One inch of rain could raise the moisture content of 4 in. of this soil by about 17 per cent. Site 1 with its grass cover would appear to have gained in moisture above the wilting point by an amount equivalent to nearly 10 in. of rain.

Table II shows the particle size distribution for the two sites. The surface of site 1 is highest in coarse sand and lowest in clay and this horizon appears to have been lost from site 2. The 1-6 in. horizon at site 1 and the 0-4 in. horizon at site 2 are similar, although site 2 has the slightly higher clay content, but it is doubtful if this difference in clay content would have much effect on the entry of water into the two soils. The figures in Table II show the high proportion of particles in the range 50μ to 2μ and it is considered this is a contributing factor to the compaction observed in the areas devoid of vegetation.

Site 2 is markedly higher in clay below 4 in. and this may account for its higher salinity for at a given moisture tension, the higher amount of clay would hold more water and so also hold more salt. The salt in site 1 does not rise appreciably before 36 in. in depth.

TABLE I.

Salt and moisture content of soils. (*Sampled June*, 1955).

Site 1 (*grassed*)

Depth in.	NaCl, %	Field Moisture %	15 atmos.* moisture %
0-1	0.007	35	
1-6	0.003	17	
6-11	0.001	20	3.8
11-18	0.005	20	7.4.
18-27	0.008	20	
37-39	0.05	10	
39-45	0.02	3	

Site 2 (*bare*).

Depth in.	NaCl %	Field Moisture %	15 atmos.* Moisture %
0-1	0.05	8.7	
1-4	0.15	7.2	
4-11	0.05	9.3	9.1
11-19	0.06	11.6	11.5

(All results quoted on oven dry basis).

*Pressure membrane determination corresponding to pF 4.2, wilting point. Determinations made by Dr. J. P. Quirk, formerly C.S.I.R.O., Division of Soils.

*For convenience of comparison all values for chlorides have been quoted as NaCl although it is known that sodium is not always present in amounts equivalent to the chloride found.

TABLE II.

Particle size distribution.

Site 1 (*grassed*).

Depth in.	Coarse sand	Fine Sand		Silt	Clay
	2 mm to 0.2 mm %	200μ to 50μ %	50μ to 20μ %	20μ to 2μ %	<2μ %
0-1	17	47	14	13	4
1-6	6	45	21	17	8
6-11	3	38	26	22	9
11-18	2	32	25	26	16
18-27	2	29	39	24	6
37-39	2	29	36	22	11
39-45	3	28	45	23	1

Site 2 (*bare*).

Depth in.	Coarse Sand	Fine Sand		Silt	Clay
	2 mm to 0.2 mm %	200μ to 50μ %	50μ to 20μ %	20μ to 2μ %	2μ %
0-1	9	40	21	18	10
1-4	8	37	23	20	12
4-11	6	26	23	23	22
11-19	3	20	17	30	30

The data show that the lack of vegetation is concerned primarily with water entry rather than a deficiency of nutrient elements. The question arises as to how frequently moisture and not nutrition is limiting in areas generally considered to receive satisfactory rainfall.

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A SIMPLE TECHNIQUE FOR DETERMINING THE STABILITY OF SOIL AGGREGATES BY WET SIEVING

Introduction

Normally there is a high degree of variation among repeated determinations of the aggregate stability of a particular soil by usual wet sieving methods.

The following simple method which has been developed and used successfully in the Agronomy laboratory of the Division of Plant Industry, Canberra gives results which show a much lower coefficient of variation than the standard Yoder technique (1936).

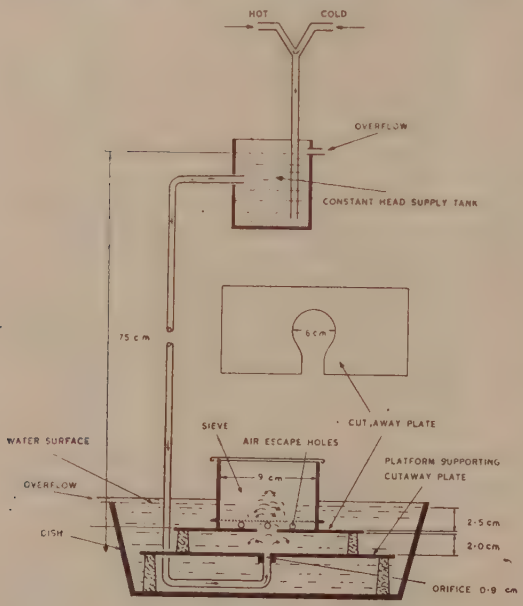

Figure 1.
The washing device.

Method

The washing device (Figure 1) consists of an upward stream of water emerging through an orifice 0.9 cm. in diam. and 4.5 cm. below the surface of water in a dish. The stream flow is maintained at a constant rate by feeding from a tank 75 cm. above the point of exit. A 9 cm. sieve with a 0.025 cm. mesh and four 0.9 cm. holes drilled through the bottom flange to allow air to escape is then placed on a cut away plate supported 2.5 cm. below the water surface on rubber stoppers over the ascending jet of water .

The sample of soil is dry sieved to remove all particles outside the range of 0.025 to 0.119 cm. Vegetable matter is then removed by a fan blast and by hand-picking. After thoroughly mixing the remaining sample, weighed sub samples each of 20 g. are taken for the determinations.

After moving the sieve to get rid of all entrapped air the 20 g. sub sample is then poured on to the wire mesh. Keeping the bottom of the flange just clear of the cut away plate the sieve is rotated by hand until the water has cleared and then is gently moved occasionally until 15 minutes have elapsed from the beginning of the washing.

TABLE I.

Comparison of Yoder and new methods.

Soil type	Yoder		New Method	
	% retained	Coeff. variation	% retained	Coeff. variation
Dickson loam	53.8	6.48	58.2	3.25
Thulabin loam	12.6	4.92	69.3	1.67
Katandra clay	6.4	25.47	10.8	2.66
Ballingal loam	54.3	14.47	53.2	1.09
Colchester clay	27.9	9.79	16.8	4.62

The sieve is then lifted, water allowed to drain away and placed in a drying oven at 90°C for one hour. After drying, the soil is removed from the sieve and weighed. It is important when using a flanged sieve that holes be drilled in the flanges to allow entrapped air to escape before sieving is commenced. Failure to remove entrapped air can cause a great variability in results. Alternatively, a sieve without a bottom flange would be satisfactory.

Discussion

In order to compare results from this and the Yoder method, six sub samples from each of five quite different soils were prepared, three being used for each method. The temperature of the water used was 20°C in both methods, and it is important that this is kept uniform during the wet sieving (Blackmore 1956).

The results from the Yoder and this new method are shown in Table I.

The amounts of soil retained by the two methods show the usual variation that occurs when different techniques are used, but the reproducibility of result as shown by the coefficients of variation was considerably better with the new method. The simplicity of the method makes it suitable for use by agronomists and other workers who have not a well equipped soil laboratory at their disposal.

Acknowledgements

The assistance of W. D. Andrew in encouraging the development of this project is gratefully acknowledged.

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BOOK REVIEW

CITRUS GROWING IN AUSTRALIA

By F. T. BOWMAN

(*Australian Agricultural and Livestock Series, Angus and Robertson,* 1956, £3/3/-.)

This is the first Australian book to deal with the citrus industry. Dr. Bowman has set out to weave together knowledge from the related agricultural sciences of climatology, soil science, botany, hydraulics, entomology, pathology, etc., with cultural practices that have developed over many years. His lifetime contact with citrus growing throughout Australia has enabled him to bring together the many relevant research findings. Australian research into nutrition, irrigation, drainage, pests, diseases, and varieties and rootstocks and their relation to quality, production, diseases and soil conditions has in a number of cases been unique and always of particular value to Australian growers.

Modern practices in the various phases of the citrus industry are described. Necessary features of the environment, selection and development of land, propagation, planting and management are all there as well as the packing, processing and marketing.

An original and interesting inclusion is Dr. Bowman's historical study of the introduction and development of the citrus industry in this country.

"Citrus Growing in Australia" meets a long standing need and will prove valuable to practical men, students and scientific workers. The excellent list of references is invaluable.

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LETTERS TO THE EDITOR

Catchment Deterioration — A Combined Agricultural and Forestry Problem

Sir,

"The flood problem in New South Wales" (this Journal, March, 1956) and, one should add, in South Australia and Queensland, is regularly publicised. Together with drought, fire and cyclones, flood disasters have come to be accepted as inescapable annual features of the Australian environment. While these problems are not peculiar to Australia, the rapid deterioration of primary biological resources in a country settled for only 160 years is certainly unique. It is evident that the high standard of living which we enjoy in Australia has not depended on superior technology, but on exploitative land use. Now that arable land has ceased to be an unlimited commodity (cf. Gordon, 1956) the old empirical techniques—which in some marginal Rain forest areas of eastern Australia even resemble native systems of "shifting cultivation"—are no longer possible. Land dedicated for timber production has reached a dangerously low minimum, and cleared agricultural lands have declined in fertility. There have been spectacular successes in the extension of agriculture to wastelands—such as the 90-mile plain in South Australia—while State water and soil conservation authorities have begun to restore old eroded productive lands. But comprehensive land classification and planning, on a national basis, has yet to be achieved. This delay is partly political—due to Federal and State antagonisms, and partly psychological—just because the problems are universal, intimate, and so amorphous.

The Symposium on the N.S.W. Flood Problem organized recently by the Institute was a worthy scientific beginning to pool ideas, but the omission of a forest ecologist—or, indeed any biologist—among the contributors resulted in a superficial consideration of the biological aspects of the problem. It is here intended merely to put forward a biological point of view, without claiming to be systematic or complete.

In the Symposium, Kaleski summarised methods of flood mitigation, and limited his discussion to "one phase of soil conservation, namely, infiltration and run-off. . . . We cannot stop the rainfall, but can we do anything to lessen the run-off?" The present discussion will be similarly restricted and deals only with factors dependent on vegetation. Kaleski quoted experimental data from various farm areas under relatively low rainfalls, to illustrate assistance to the flood mitigation engineer by suitable conservation measures. Nevertheless, it is a geographical fact (pointed out by Devery) that the Dividing Range produces coastal rivers falling steeply from short headwater tracts in high rainfall areas along the eastern coast. Hence measures to reduce run-off in such areas must include afforestation of watersheds. While Young had mentioned the need for the latter, the hydrological role of trees was incompletely appreciated. Thus forest litter was stated to be of advantage only because it can "absorb and hold twice its own weight of water . . . the effect of afforestation is not great as flood rains usually follow a period of soaking rain when the ground and the litter are saturated."

More importantly than its "sponge" action, forest humus and litter promote infiltration and deep seepage. Canopy interception, stem-funnelling, and tree root channels assist deep percolation (e.g., Rao, 1955). Rain forest soils such as red loams have an excellent physical structure, and are generally deep. The constant removal of water from the soil by transpiration means that soil storage capacity is continually renewed. Thus surface flow is delayed, even after heavy rains, on forested slopes.

By contrast, bare soils, or cleared and badly managed farm soils, rapidly become compacted and puddled on the surface, resulting in flash runoff and erosion.

The following example, from Whian Whian State Forest, near Lismore, N.S.W., reveals striking differences in infiltration rates measured when the surface soil was at approximately field capacity (a normal condition during the wet season):

(a) For basaltic clay loam or loam under Vine forest versus grassland, rates were 38 in./hour and 1.2 in./hour, respectively.

(b) For rhyolitic sandy clay loam or sandy clay under logged Sclerophyll Fern forest versus burnt Sclerophyll Fern forest, rates were 30 in./hour and 10 in./hour respectively. (G. B. Stirk and L. J. Webb, unpublished data.)

Besides surface runoff, flooding, and outright erosion, deforestation has resulted in a more subtle deterioration of soils—so-called declining fertility (e.g., Lismore area). Subtropical Rain forest soils have, in fact, a reputation for being chemically impoverished, so that the growth of luxuriant, many-storeyed vegetation on them is regarded as paradoxical (c.f. Richards, 1952). This view fails to appreciate the magnitude of "above-ground fertility" in Rain forest soils, i.e., the nutrients immobilised in plant matter above the ground, and circulating in the little cycle.

Measurement of the weight and composition of leaf litter returned annually in different forests at Whian Whian, N.S.W., gave the following results for Subtropical Rain forest:—

Dried weight of leaf litter	6,022	lbs per acre
Calcium	93	„ „ „
Potassium (total)	35	„ „ „
Phosphorus	11	„ „ „
Nitrogen	132	„ „ „
Magnesium	20	„ „ „
Sulphur	18	„ „ „

It should be noted that these results refer to fallen leaves only, excluding bark debris, branches, etc. A rough calculation (J. G. Tracey, unpublished data) gives the following conservative idea of amounts of nutrients immobilised (cf. Bartholomew *et al.* 1953) above ground in a typical subtropical Rain forest of northern N.S.W.:—

Potassium	2,630 lbs per acre
Calcium	5,140 „ „ „
Phosphorus	265 „ „ „
Magnesium	1,694 „ „ „

Clearing and burning of subtropical Rain forests result in destruction of microflora and humus, and accumulation of surface ash as a temporary source of available minerals. Generally, there follows a lowering of soil nitrogen, pH, replaceable calcium, and available phosphate (King, 1949).

To conclude, there seems little doubt about the importance of forests, particularly Rain forests and associated sclerophyll forests in high rainfall areas of eastern Australia, in terms of maintaining and restoring desirable soil water relations and soil fertility. While non-biologists may prefer to restrict flood mitigation to engineering projects, afforestation is an easily controlled variable which will pay increasing dividends, both in production and protection, as time goes on. The most rational land use, planned on a long-range and national basis, requires co-operation of forestry, agricultural and pastoral authorities and industries. This planning is an essential preliminary for maintenance of Australian prosperity and an increasing population. Catchment misuse (e.g., destruction of forests in favour of a precarious agriculture, neglect of "farm woodlots" on upper slopes) affects both forestry and agricultural production, now and in the future. An international study on "Soil Conservation" made by F.A.O. in 1948 fittingly summaries the problem confronting Australia:—

> "The attention to forest lands and soils in this report is based on the stern fact that a nation cannot conserve its true cropland soils and ignore its mountains and forests. Nature accepts no such arbitrary division of the lands of the earth. The simple fact is that most farms are in valleylands and plains that lie downhill from the mountains, and water runs downhill. . . Good and permanent agriculture depends on good and permanent forestry. It is a dangerous, and indeed fatal, delusion to imagine that the prime essential of land use—for food production—can survive unless government and farmer alike give jealous attention to the non-farm lands which support or destroy farm enterprise."

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April 9, 1957.

Publication of Agricultural Research in Australia

Sir,

It concerns me deeply as a professional agriculturist that there is in Australia today a vociferous school of thought that tends to belittle the importance of good "earthy" agricultural research, and to laud on the other hand research that is described as "fundamental". This attitude, while it professes to be inspired by the most high-minded zeal for the advancement of scientific endeavour in agriculture, is in fact an expression of ignorance of the real nature of agricultural research. Such ignorance may do no harm while it is confined to those who express it, but it may do great harm if its influence is brought to bear on the publication of the results of agricultural research.

What is it that sets agriculture apart from other human pursuits? The essential feature of agriculture is *production* of vegetable and animal materials needed for the feeding, clothing and welfare of the human race. "Production" is the keynote of the whole thing. The essential inner reason for agricultural research is problems of "production". My definition of "Agricultural Research" is as follows:—

"Agricultural Research is scientific research dedicated to the solution of problems relating to the maintenance of existing levels or the achievement of new levels of agricultural production, and to the obtaining of new data relevant to the solution of those problems".

Agricultural research *is* applied research, The very use of the adjective "agricultural" means just that. Let me illustrate by several examples. If a man studies the size and distribution of particles in a number of soils simply to find out how they are made up, that is soil science and he will publish his findings in a journal of soil science or perhaps mineralogy. But if he compares the size and distribution of

particles in the soils to determine whether this has any bearing on their fertility as measured by crop production, then that is agricultural research, and his findings may be published in a journal of agricultural research. If another man takes some pots of soil, plants a species of clover and applies different levels of phosphorus simply to see what growth response that species makes to phosphorus this is botanical, or perhaps plant physiological research. But if he takes soil from a certain agricultural region and performs the same experiment to determine what level of phosphorus addition will produce the best plant with a view to beginning or increasing production on that soil, then he is engaging in agricultural research. The reason for existence of the "agricultural" research worker is to take basic data accumulated by the pure disciplines of botany, zoology, chemistry, etc., and apply them to the solution of problems of agricultural production. If at any stage in his investigation of a problem he comes to a point where basic data are not available and yet are essential to the solution of his problem, he may then set out to obtain these data, without losing sight of his main objective. Should the pursuit of these basic data at any time exercise such a fascination for him that he follows this line as an end in itself, he ceases to be an "agricultural" research worker and becomes instead merely a disciple of the particular discipline he happens to be working in, be it biology, chemistry or what you will.

It follows then that the bulk of "agricultural research" papers do not bring forward any new principle or any new basic physical, chemical or biological data. They demonstrate instead how, by the application of this or that known fact in the right way, a certain *problem* may be overcome. A small minority of papers will present new principles or data. However, if these latter do not clearly indicate that they were produced because of the initial stimulus of an agricultural problem, they are not agricultural research papers and have no place in a journal of agricultural research, but belong rather to the journal of the appropriate discipline.

There is a grave danger that the Australian Journal of Agricultural Research may lose much of its value if the "purists" are allowed to exercise an undue amount of influence on its editorial policy. It is the second "A" of A.J.A.R. that is the very reason for its existence. To place a higher value on papers of a "fundamental" nature, that is, on papers that bring forward new principles or new basic data, than on the bulk of agricultural research papers that set out to solve problems of agricultural production, is to deny the reason for existence of the Journal. One hears repeatedly talk of finding some avenue of publication other than A.J.A.R. for agricultural research papers of the "more applied" kind. This is pure nonsense. In a journal of agricultural research the bulk of the papers *must* be applied, or they have no right to be there. Criticism of papers because they are "too local" in their application may also be nonsense of a high order. Research designed to bring into production a hitherto undeveloped corner of Australia is agricultural research of the best kind; and who is to say that the methods used to render productive a piece of western Victoria or of south-eastern Queensland will not be of interest to a worker in Uruguay or Brazil?

This is not to deny the fact that certain papers might be submitted that are of a very routine "testing" nature. For example, a paper might be submitted setting out the results of a comparison of a dozen commercial fungicides for the control of a well-known plant disease, and concluding that Brand A was superior. The A.J.A.R. would be justified in rejecting such a paper because ample scope exists elsewhere in the form of Department of Agriculture Journals for such material. It is far more legitimate to set up a distinction between "agricultural research" and "agricultural testing" papers, than between "fundamental agricultural research" and "applied agricultural research".

I wish to make a plea that if any changes be made or contemplated in the avenues of publication available to agricultural scientists in Australia, no action be taken without consulting the body of men best qualified to give an opinion on the subject. I refer to the Australian Institute of Agricultural Science to which nearly all professional agriculturists in Australia belong. The opinion of these men, obtained if necessary by questionnaire, would give a true guide to the publication needs of agricultural science in Australia, and what is of equal importance, would ensure a majority opinion in true democratic tradition.

D. NORRIS.

C.S.I.R.O.,
Plant and Soils Laboratory,
Brisbane.
July 26, 1957.

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TALKS

The Institute and its Future.

Presidential Address by R. M. Moore to the A.C.T. Branch Annual General Meeting, 8th March, 1957.

I have chosen to speak to you tonight on "The Institute and its Future", not because I consider myself particularly qualified to do so, but because I think the subject is appropriate at the present time and because a Presidential Address is an appropriate occasion for reviewing the past and suggesting the future. I propose, with your permission, Mr. President, to forego the privilege normally accorded presidential addresses and to invite discussion from the floor of the meeting at the conclusion of my talk. I do this because I feel that Members should consider carefully the issues confronting the Institute, and that they should give expression to their opinions for the guidance of the incoming Branch Committee and of the Principal Delegate. I hope therefore, that what I have to say may stimulate ideas within your minds and may provoke you to express them here or elsewhere.

In order to obtain a perspective I propose to review briefly the historical development of the Institute as I see it. The A.I.A.S. was conceived as an organisation of graduates in agricultural science. It is probable—certainly it was in the mind of many rank and file members—that the founders had in mind an organisation paralleling, in some respects, the B.M.A. or the Australian Veterinary Association, that is, an organisation which, like these two, would increase and protect the status of members, and promote the appointment of graduates to certain positions in the professions open at the time to both graduates and non-graduates. The attempt to exclude non-graduates from membership at a time when many of the senior positions in the agricultural hierarchy were held by non-graduates created a great deal of bitterness and led to the formation of a rival organisation which had a brief existence before the Institute capitulated and admitted certain senior non-graduates. Hence the origin of Article 4 Clause (iii), originally intended to operate for 3 years only, but which has been a bone of contention in the Institute and a regular heading on Council Minutes ever since. At the present time, you are once again being asked to vote on an amendment to this clause. The issue is—do you wish to retain a degree of exclusiveness, or do you wish the Institute to be more fully representative of the agricultural profession?—if the latter, where do you draw the line?

Those who had hoped that the Institute would be a kind of trade union were doomed to early disappointment. It soon became clear that the Institute could take no direct action on salary matters; the majority of its members being State Government Employees covered by existing professional associations with access to different arbitration systems in six States. The only action the Institute could take on salary matters would be an indirect one—such action is being taken by two branches at the present time.

It is reasonably clear also that it was intended originally that the authority and management of the Institute should be vested in a strong central council and that the emphasis should be on an Australian Institute rather on a loose federation of branches more or less self-contained within themselves. However, the fact that the majority of members are employed by Governments in six States has been and is a powerful force against the concentration of management authority in a Central Council. That this centralisation of authority was not achieved is known only too well to those who have sat on Council as Principal Delegates. The real power has been in the Branches—Principal Delegates have been merely mouth-pieces of the Branch Committees and because it has been rare to find all Delegates adequately briefed, the expedition of Institute business has been painfully slow.

Prior to, and immediately after the war, the Institute was a group of seven societies with a Central or Federal Council, the main productive activity of which was the publication of a Journal. I don't mean to suggest that Council had nothing to do—to the contrary it had more than enough to do, but its activities were of a secretarial rather than a policy-making nature—the initiative was with the Branches and naturally enough their interests were mainly those of their particular State. It was the increasing burden of secretarial, editorial and accounting work borne by honorary secretaries, treasurers and business managers which led firstly to the idea of a paid secretary and later, possibly under the influence of the changed political scene in Australia, to the idea of a central office of management and the freeing of Council for policy making activities.

The establishment of a central office was not achieved without opposition from those who liked the Institute as it was—a series of societies providing Members with opportunities for hearing lectures on agricultural matters. Neither has there been widespread approval of the activities initiated by central office—at least there is a great deal of uneasiness at the success of these activities—I refer to the recruitment drive, to the publicity campaign and to the appeal to industry for financial aid. The essence of the trouble is that Central Office, through its executive officer, in the absence of any ideas from Branches or from Council, has had both to supply the ideas and to carry them out.

This then is the situation as I see it in the Institute today—There is an energetic and expanding Central Office lacking satisfactory direction from Council, not because of any faults of individual Delegates, but because the Branches they represent have not been conditioned to

think in terms of Australian agriculture. There is, in addition, in spite of the existence of a Central Office, a slow turn over of business in Council because of the reluctance of Branches to endow their Principal Delegates with the requisite authority and freedom of action. The A.C.T. Branch has suggested that consideration be given to the appointment of Principal Delegates for extended periods and the retirement of Delegates in rotation to ensure the presence on Council of a nucleus of Members familiar with Institute business. I think some such arrangement is essential, but equally important, Branches must be persuaded to brief their Delegates fully and to allow them some freedom of decision.

Apart from these organisational difficulties and weaknesses, there are contentious issues facing the Institute at the present time. There is as I have said, a growing opposition to the concentration of management authority in Central Office and to the activities of that Office in such matters as recruitment and the soliciting of funds from industry. There is also, of course the hardy perennial—qualifications for membership. Transcending even these problems is the apathetic attitude to the Institute of a large body of its members—it is probably true to say that the majority of members show little or no interest. The evolutionary rates of the agricultural scientist, on the one hand, and of the Institute on the other have been different. Members today have not precisely the interests of those of 20 years ago. There has been greater diversification, and, what is more important, greater specialisation. In Australian universities —20 years ago there were little or no opportunities for post-graduate training; today the situation is entirely different and the scientific world is peopled by specialists. Scientists working in the field of agriculture have been affected no less than those in other fields and there has been an ever increasing tendency towards specialisation. I don't mean that there were no plant pathologists etc. 20 years ago, but such people were more apt to think of themselves as agricultural scientists than they are today—how many Institute members class themselves as agricultural scientists on taxation returns? Indeed, the non-specialist in unfashionable, and his standing in the scientific community is relatively low.

The picture I want to give you is of an Institute composed of members with diverging and narrowing interests—interests which in many cases lead them afar from the field of agriculture. The old agricultural scientist is becoming rare, even though a large and increasing number of scientists are engaged in research and other activities in the field of agriculture.

The Institute has recognised this, perhaps unwittingly, by its amendment of Article 4 Clause (ii) which now makes it easier for graduates in faculties other than agricultural science to join the Institute. The question is how many will want to, and more important, will the Institute continue to retain the interest of existing and potential members even of those who graduate in agricultural science.

Already we have seen the formation of a Soil Science Society and a Society for Animal Production—many of the members of which are either members or eligible for membership of the Institute. As these societies grow—are Institute members who belong to them likely to remain very interested in the Institute? The Institute is already aware of this particular problem, but I am doubtful if it is aware fully of the implications or of the likelihood that there may be more and more of such societies formed in the future.

I suggest that the Institute should resolutely face the situation and that it should reorganise itself so as to meet the interests and needs of its members without waiting until it is forced to do so—it may then be too late. Such a reorganisation may involve rather drastic alteration of the Constitution, but I suggest that this may be better than the piecemeal alteration which has been in progress for the past few years.

It is of interest to note that there are very few comparable Associations of Agricultural Scientists in other parts of the world. The only one of which I am aware is the Agricultural Institute of Canada which has a membership of about 3500 and 24 branches. It admits non-graduates to associate membership and publishes two journals, one of which is the well known "Scientific Agriculture". Apparently the Canadian Institute caters to the varying interests of its members through scientific sub-committees and achieves co-ordination and integration through an annual convention.

I think in our own case we might achieve such an inter-linking of interests by forming semi-specialised groups or Divisions within our membership, e.g. Grassland Division, Economics and Administration, Agronomy and Plant Breeding, Soils, Pathology and Microbiology etc. Where strong enough, such groups could form themselves into societies within the framework of the Institute. Societies already in existence outside the Institute such as the Soil Science Society and the Animal Production Society may be induced to become part of the Institute. The advantages from their viewpoint would be the existence of a paid Executive Officer and Central Office for administration, and free association with scientists in other fields; the disadvantages would appear to be negligible, particularly if they were allowed to determine their own membership qualifications. Where members of a society or division are not eligible for full membership of the Institute, they should be accorded associate membership. I would suggest associate membership should be available to all persons associated with agricultural pursuits including graziers and farmers. Full membership could be reserved for graduates as at present, and if considered desirable, office-bearers could be restricted to this class of membership.

The Institute has accepted the principle of membership classes, i.e., Fellows and Ordinary Members and the inclusion of associate membership is merely an extension of this principle. This would place the Institute on the same basis as many other societies whose membership classifications are used as a guide by employing organisations.

In time the Institute may be able to publish journals for the special needs of its member societies. This and the provision of post-graduate scholarships may be a satisfactory way of using

money donated by industry—particularly if the scholarships are chosen in fields relevant to the interests of the industries concerned e.g., weed control, plant nutrition, insect control, etc.

Such a scheme could I believe, make the Institute truly representative of Australian agriculture—it would give the members throughout Australia an interlinking interest in a common and more restricted field of work, it would tend to break down State and Institutional barriers, and it would at the same time make the Institute and its members more aware of the wider problems of Australian agriculture and hence direct its activities to the most appropriate channels.

It may seem contradictory to suggest on the one hand that the Institute should cater for the specialist interests of its members and at the same time admit as associate members people with wider interests. However, I don't believe that this is so, and that in actual practice relations would be fostered between the research officer, the extension officer and the practising agriculturalist and each would be more aware of the other's problems. The provision of such a channel of communication between these groups might well be a major activity of the Institute.

The Reduction of Evaporation from Water Storages by Surface Films

W. W. Mansfield, Division of Industrial Chemistry, C.S.I.R.O., Melbourne in an address to the A.C.T. Branch, 16th May, 1957.

There are two types of surface film known to reduce evaporation in the laboratory. Monomolecular films of many substances possess this property to an extent varying with the chemical composition and physical structure of the film. Much thicker films of some spreading oils are able to reduce evaporation, usually more greatly than monomolecular films.

Any treatment efficient in the laboratory will reduce evaporation in the open only if it be resistant to the action of wind, wave and dust. The duplex oil films are not capable of resisting sufficiently these hazards, but some monomolecular films possess the desired properties of fluidity and high spreading pressure.

Cetyl alcohol is a cheap, non-toxic chemical which, while floating on water, generates spontaneously a monomolecular film. Many substances act similarly, but cetyl alcohol is the most useful of a few which form monomolecular films of the required type and exhibiting considerable resistance to evaporation.

To spread and maintain a monomolecular film on open water, some method of replenishing the film is required. Although losses from the film by adsorption on dust, on the shore-lines and by solution in the water are extremely small, the amount of chemical comprising a monomolecular film is also extremely small (about 1/5 oz. per acre), so that any permanent losses are serious. Additionally, the film is diluted whenever waves form upon the surface, so that more chemical must be applied to the film as rapidly as possible after waves have formed.

The film is replenished continuously as required by maintaining a supply of solid cetyl alcohol upon the surface. The physical and chemical nature of this supply determines that rate at which fresh chemical is supplied to a waning film, and thus also determines the average efficiency of the film in reducing evaporation. A study of the factors involved has led to the development of the "Siroseal" technique, designed specifically for use on station tanks and very small reservoirs.

On large areas of water the process designed for small storages has several disadvantages. These may be overcome by modification being developed at present, or they can be eliminated by using an entirely different technique of spreading monomolecular films. Drops of a solution of cetyl alcohol in a petroleum-type solvent spread on water, leaving a monomolecular film of cetyl alcohol after evaporation of the solvent. At Stephen's Ck Reservoir, Broken Hill, an experimental application of this technique last summer reduced evaporation by 35 to 40%.

Future work on this subject will follow several directions. There is room for improvement of the technique in use on small storages while further laboratory and field work is required to consolidate the initial success obtained with the technique using a solution of cetyl alcohol. The utility of variations of both these methods must be assessed. Finally, it will be necessary to demonstrate the applicability of the method to very large reservoirs.

Use of the method will make the storage of water more reliable and cheaper. In arid regions the loss of water by evaporation is always several times greater than the amount consumed, and there is often an interval of 1 to 2 years between catchment rains. In these circumstances the life of a storage is of major importance, and reduction of evaporation extends this life. As a further development, reduction of evaporation increases the effective capacity of a reservoir, so that it may be used as a cheaper alternative to the construction of an additional storage.

Rainfall—Natural and Artificial

Dr. E. G. Bowen, Chief, Division of Radio Physics, C.S.I.R.O.,

An address to the A.C.T. Branch, 14th June, 1957

The Physical Processes of Rain Formation

It is well known that a great many conditions must be satisfied in the atmosphere before rain falls. To quote only a few—there must be an adequate amount of moisture aloft, the air should preferably be unstable in order to replenish the supply of moisture aloft, and there should be an adequate supply of nuclei on which cloud droplets or ice crystals can form. The possibility of inducing rain to form artificially is based on all but one of these conditions being satisfied. If then the missing factor can be supplied artificially, there is a possibility of producing rain which would not have fallen in the natural course of events. The missing factor on which most rainmaking methods are based is the last of the three mentioned above and the method of operation is to provide a supply of condensation or freezing nuclei if these are not available naturally.

In general, we can distinguish two main processes by which natural rain falls:—

(a) *Rain from Warm Clouds*

This type of rain is of frequent occurrence in tropical and sub-tropical regions. Clouds normally consist of a large number of very small water droplets. The concentration may be several hundreds per c.c. and their diameter about 200 microns. These droplets are normally in a state of colloidal stability and such clouds will often persist for many hours without dissipating and without precipitating out. If, however, coalescence of the droplets takes place, rapid growth is possible and raindrops are formed. The exact process by which coalescence begins is not clearly understood, but it is known that the presence of unusually large condensation nuclei, for example in the form of salt nuclei which have come up from the sea is a contributing factor. These nuclei lead to the formation of cloud droplets which are substantially bigger than their neighbours. They fall relative to the smaller drops, collide with them and grow rapidly by coalescence.

(b) *Rain from Supercooled Clouds*

Another process by which the colloidal stability of a cloud of water droplets can be upset occurs in supercooled clouds. If, for any reason, ice crystals appear in the cloud, the ice crystals tend to grow rapidly at the expense of the water droplets. They form snowflakes and large ice crystals which commence to fall through the cloud, growing further by collision as they fall. As they reach warmer parts of the cloud they melt and form large raindrops which then emerge from the base of the cloud as rain. This is the well-known Bergeron process of rain formation.

When a cloud builds up to the higher levels of the atmosphere, water droplets normally do not freeze when the freezing level is reached. They remain in the supercooled state and under average conditions ice crystals do not appear until a temperature of about —15°C. is reached. There are wide variations in this temperature from time to time, however, and there are occasions on which clouds have attained temperatures of —20° or —25° without ice crystals appearing.

Artifically Induced Rainfall

It will be clear from the above that there are at least two ways in which clouds which are already in existence might be induced to precipitate out.

(a) In the case of warm clouds, particularly those in the interior of a continental land mass, there may be adequate quantities of moisture aloft but an absence of giant condensation nuclei on which larger droplets can form to commence the coalescence process. Such clouds might be induced to produce rain, therefore, if giant nuclei in the form of salt crystals or other hygroscopic materials are introduced into the moist air at the base of the cloud. As an alternative, water droplets themselves might be sprayed into the cloud, provided only that the dimensions of the spray are larger than those of the droplets already in the cloud.

Extensive tests of the water spray process have been carried out both in Australia and in the United States of America and the results leave no shadow of doubt that rain can be induced to fall by this method. The aircraft flies either through the base of the cloud or through the top, depending on the magnitude of the vertical air currents in the cloud, spraying some hundreds of pounds of water droplets, 50 to 100μ in diameter, per mile of travel of the aircraft.

(b) In the case of stable super-cooled clouds in the atmosphere, the requirement is to introduce artificially an adequate number of ice crystals. Following Veraart and Langmuir, this can be accomplished by dropping pellets of dry ice through the cloud. The dry ice is at a temperature of —80°C. and each particle cools a thin pencil of air to such a temperature that large numbers of ice crystals form spontaneously along the path of the dry ice. Some millions of pellets of dry ice are dropped and millions of ice crystals per metre of travel of the pellets are formed.

In practice, some tens of pounds or hundreds of pounds of dry ice are required per mile of travel of the aircraft to produce an adequate number of ice crystals in convective clouds, and a great number of experiments of this kind conducted in many parts of the world again leave no doubt that rain which would not otherwise have fallen can be produced by this method.

Application Over Wide Areas

If an aircraft is required to go into every cloud which is seeded and deposit some hundreds of pounds of water or dry ice, the method becomes hopelessly uneconomic for use over wide areas. The cost of the operation would far exceed the return in the form of additional rainfall. Before the methods can be adopted on a wide scale, therefore, much more economical processes must be discovered.

At the present time we know of no method which might improve the economics of seeding of warm clouds, but there is very real hope that this can be done in the case of supercooled clouds. The hopes are based on a discovery by Vonnegut that chemical materials like silver iodide can be effective as ice nucleating agents. The crystal structure of silver iodide is similar to that of ice and the lattice dimensions almost identical. If small crystals of silver iodide are therefore introduced into a super-cooled cloud, water vapour is transported across to them exactly as if they were ice crystals, and the subsequent growth of these crystals takes place as in nature. Silver iodide particles begin to be effective as freezing nuclei at a temperature of —4°C. and are fully effective at —10°C., that is, at a temperature which is significantly warmer than that at which ice crystals appear in nature. There are many clouds, therefore, with their tops at temperatures from —4° to —15°C. which are not likely to rain naturally but which are susceptible to silver iodide seeding.

One property of silver iodide which gives hope of improving the economy of the method is that it can be used in a very finely-divided form. One gram of silver iodide can produce upwards of 10^{16} nuclei which are effective in the above temperature range. This means that a few pounds of silver iodide would be sufficient to seed the whole State of New South Wales.

Aircraft Seeding

Most silver iodide seeding activity in Australia at the present time is carried out from aircraft. The work is on an experimental basis and the

purpose of the experiments is to attempt to answer the two broad problems:—

(a) If silver iodide is dispensed into supercooled cloud systems will it induce rain to fall and what are the optimum conditions under which this might happen?

(b) What change in net rainfall would result from a continuation of a seeding operation in one area over a long period.

These experiments are proceeding actively and it may be some time before final conclusions can be drawn. However, it is possible at this stage to give a report of progress:—

(a) In the first place, there is no doubt that when silver iodide is introduced into supercooled clouds, either into the top of stable cloud systems or in the base of convective cells, precipitation is induced to fall. The optimum conditions under which this can occur are not yet as well known as they are for dry ice, but it is hoped they will be determined in the near future.

(b) The fact that silver iodide can successfully induce rain to fall from cloud systems does not mean that there would necessarily be an increase of rainfall over an area if the process were repeated a large number of times, and this question must be separately investigated by experimental tests. In cases where precipitation which would not otherwise have fallen is induced to fall, clearly there would be a net gain in rainfall.

When precipitation is induced to fall earlier than would otherwise be the case, however, the situation is not quite so simple. Such precipitation, being released earlier, might consist of smaller raindrops. These would evaporate more rapidly on emerging from the base of the cloud and the net rainfall on the ground might conceivably be decreased.

Under the latter circumstances, the conditions conductive to an increased rainfall are those with a low cloud base. When the cloud base is high, it is conceivable that seeding operations could either reduce or cause no change in the net rainfall.

Application to Arid Lands

If it is established that significant increases in rainfall can be achieved in regions like the Snowy Mountains, one can almost certainly say that the percentage increase in rainfall would become smaller as the experiment were moved in the direction of the more arid regions of Australia. The reason for this is simply that the number of opportunities for seeding would be progressively reduced and become very small as the rainfall approached zero.

However, there are many special cases in which favourable conditions might be found in the arid regions. For example—

(a) Some arid regions depend for their water supply on rivers which have their source in high rainfall regions. There is often considerable loss of water from the river in its course by water utilization and evaporation. Under these conditions a 10% increase in precipitation at the source might represent a 100% increase in the flow near the end point. There is considerable hope, therefore, of increasing the available water in these regions by means of seeding operations at comparatively distant points where the opportunities for seeding might be more frequent than in the arid regions themselves.

(b) A second point is that in some crops grown in arid regions a comparatively small quantity of rain *at the right time* can lead to a quite disproportionate increase in the yield. Wheat is one example of a crop which is very sensitive to the amount of rain which falls during the germinating period; a quarter of an inch of rain at that time can make all the difference between success and failure. It is possible, therefore, that rainmaking operations during a very restricted period of the year in such regions might yield very valuable results.

(c) There will always be some arid regions in which it will be difficult or impossible to augment the rainfall by artificial means. The deserts of central and western Australia may come into this category. However, there are others, depending very much on their geographical situation, in which the techniques of rainmaking might be exploited. For example, the air in the first 10,000 feet over Arizona is among the driest in the U.S.A. However, in summer this is frequently overlaid by tropical air which has its origin in the Caribbean and carries more water than that in any other part of the U.S.A. If this moisture could be induced to precipitate out, it might make a profound difference to the summer rainfall of the south-western States of the U.S.A.

Botanical Observations in Europe

Professor D. A. Herbert, Professor of Botany, University of Queensland

An address delivered to the Queensland Branch

Ireland: The climate of Ireland is more equable than that of Great Britain being influenced by the Gulf Stream, and the rainfall is heavier and well distributed. Whereas Eucalypts are rare in outdoor cultivation in Great Britain, a number of species including *Eucalyptus globulus, E. macarthuri, E. gunnii, E. rubida* and *E. viminalis* do remarkably well in Ireland, and round Dublin such Australian plants as treeferns (Dicksonia) and Tasmanian beeches grow in the open. Queensland plants, as elsewhere in Europe are grown in glasshouses; silky oak is popular as a "fern", and stinging tree as a foliage plant raised from seed and placed out of reach. Some mediterranean species, such as *Erica mediterranea* are members of the native flora in the west of Ireland. From east to west the depth of the boulder clay decreases and in parts of Galway, peat (derived from sphagnum and heather roots) often sits direct on the quartzite. Central Ireland is a wide plain about 250 feet above sea level, with a great extent of peat bog (e.g. Bog of Allen) mainly with sphagnum and heather. Removal of peat (fuel for local use or horticultural peat moss for export) may result in good growth of grass on underlying clay if it can be drained, otherwise wet sphagnum regenerates.

Holland: One half of the present Netherlands was salt marsh and swampy country in the 9th century and the other half sand, moor and heath. There is a dune belt on the west that protects the reclaimed area from the North Sea. The original height of the land in Holland proper (between Rotterdam and Amsterdam) was probably a little above sea level, with lakes. In the absence of trees, the inhabitants burnt the peat and the lakes extended. Marshy areas were first reclaimed in the 10th century and since the middle ages reclaimed land has been pumped dry by windmills. A polder is a dike-enclosed area with the enclosed water lifted to drainage canals. Dikes are of sand and clay, bound with a grass sward; in their construction mats of willow, stones, asphalt or concrete are used for stabilizing. Residual lakes in this country (which may be 12 ft. below sea level) are like full saucers above the farm lands. Water table height is controlled by drainage ditches, pumped out to higher canals. In the bulb growing areas the water table is maintained at 22 inches. Soil in the bulb areas is "inverted" at intervals to control microbial life. Clogs, worn in the wet fields where leather shoes rot quickly, are made from willow or Canadian poplar, and last about eight months under wet conditions, or a year under dry. There are acres of glasshouses between Amsterdam and the Hague with gerberas, chrysanthemums, sweet peas, carnations, etc. for the European market, sold by Dutch auction at Aalsmeer; these auctions look like our wool sales. Flower marketing is co-operative and sales are not made below a minimum price; produce not sold is destroyed, the grower getting 80 per cent. of the minimum price from the co-op.

England: Considerable work is being done in reclamation of heath moors for forestry. Heath produces a thin hard pan a few inches below the surface and the soil is unsuitable for trees. Deep ploughing to break up the hard pan and bury the heather is followed by pine and spruce planting. The trees suppress regeneration of heather and the hard pan does not redevelop. The hardwood (oak etc.) country is mostly used for agriculture. Breeding of better types of tree (selection, hybridization) is proceeding and the possibilities of hybrid vigour are being followed up. Moorland soil is being used for forest nurseries, after fertilizing and addition of humus, old agricultural soil often being unsatisfactory unless sterilized. The conversion of moor to forest does not win universal approval by any means from the huntin', shootin' section of the population.

Russian Comfrey

V. J. Wagner, Senior Agronomist Department of Agriculture and Stock, Brisbane

An Address to the Queensland Branch

Russian Comfrey (*Symphytum peregrinum*) a member of the Boraginaceae, is believed to be a hybrid of *Symphytum officinalis* and *Symphytum asperrimum*, or *S. asperum*, and was introduced to England and Europe about 1870.

In appearance, Russian Comfrey resembles a tobacco plant with short internodes and has large, somewhat succulent leaves covered with short strong hairs. Because of the multiple leaf growth at ground level, circumference of the plant is more closely related to yield than plant height. The growing habit smothers weeds in the row. Numerous purple flowers half an inch in diameter are borne on a branched stalk.

The plant seems to be suited to a wide range of climatic conditions. It has a deep root system and consequently would be expected to perform better on deeper soils. The plant grows best in soil of pH from 6-7.

Russian Comfrey is a perennial and has been known to last for a period of up to 20 years under English conditions. It is usually grown in rows 3-4 ft. apart with plants 3 ft. apart in the row. Cutting (with reaping hook or scythe) should be carried out before the plant comes to flower, the leaves being removed about 1-2 ins. above ground level. In the first year, 3 or 4 cuttings may be made and after a few years 6 to 8 are usually obtainable depending on the general growing conditions. Under ideal conditions yields of over 100 tons per acre per annum of green material have been produced by a mature crop under English conditions.

The crop is said to be palatable to all farm animals. Palatability increases after wilting has occurred since the leaves are covered with stiff hairs which in the turgid condition are troublesome.

In 1955 Russian Comfrey planting material was brought into Australia by *Mr. W. F. Savage* of Mornington, Victoria, and by *Mr. J. F. Leacock* of Glenfield Farm, Casula, N.S.W. Russian Comfrey was officially introduced to this State in 1956, when a quarantine planting of three different strains was established at Redlands Experimental Station. The three strains planted were Bocking 4, Bocking 14 and Bocking 17. These were obtained from the C.S.I.R.O. Plant Introduction Section. The plants established themselves readily and were harvested the first time 12 weeks after planting.

Analyses on the first cut showed that the three varieties were very similar in organic matter composition but differ in mineral composition. The high protein-low fibre levels tended to indicate a protein concentrate rather than a pasture. The nitrate levels were high and approached the toxic level for ruminants fed solely on this material.

Six weeks after the initial harvesting the planting was ready for cutting a second time. Harvesting was repeated with increased yields being obtained.

Bocking 4 strain yielded an estimated 6.88 tons per acre, whilst Bocking 14 produced 5.6 tons and Bocking 17 strain 5.5 tons. The average plant size prior to cutting was 12" high with a diameter of 41" for Bocking 4. Bocking 14 measured 12" x 42½" and Bocking 17 14" x 42". All the plants made a rapid recovery following harvesting. The total yields of green material/acre to date based on data from this nursery planting for a period of approximately 5 months are Bocking 4, 11.7 tons, Bocking 14, 8.30 tons, and Bocking 17, 9.22 tons.

A palatability trial showed that shade drying for 24 hours approximately doubled the palatability of this material.

Labile Nitrogen of a Darling Downs Black Earth

F. R. From, Agriculture Faculty, University of Queensland

An Address to the Queensland Branch

Preliminary investigations have been carried out seeking some nitrogen condition in the wheat plant or the soil which can be related to crop yield or quality.

Samples of a black earth from Bowenville were collected for incubation studies in the laboratory. Sub-samples of 10 grams were mixed with an equal volume of vermiculite, leached free of oxidised nitrogen, and then incubated at 32°C. The incubated samples were leached at intervals and the oxidised nitrogen determined by the brucine method.

In order to investigate the potential of this soil to produce mineralised nitrogen, samples were taken from four sites at varying depths down to four feet. All samples down to 30 inches produced considerable oxidised nitrogen when incubated for a fourteen day period. Although the compact soil mass may not produce oxidised nitrogen to this depth *in situ*, it is possible that nitrification could occur below the surface mulch as the soils dry and crack.

In the case of a series of samples which were incubated for a period of eight months the profile down to four feet produced 1000 lbs. of oxidised nitrogen in eight leachings. When this quantity is added to the nitrate in the soil at sampling, there is a total of 1200 lbs. per acre of nitrogen. This is the equivalent of 6000 lbs. of ammonium sulphate or sufficient for twenty 10-bag crops of wheat. In the eight leachings one-tenth of the total nitrogen in the 0-4 inch sample was mineralised.

These data emphasize the potential of the Darling Downs soils to supply great quantities of mineralised nitrogen when the conditions of moisture, temperature and aeration are suitable.

Nitrogen Fertilizers on Dairy Pastures in South East Queensland

A. J. Hegarty, Agrostologist Department of Agriculture and Stock, Brisbane

An Address to the Queensland Branch

In areas where soil moisture is limiting for the establishment of permanent pasture legumes, the dominant species are generally Paspalum, Rhodes and Kikuyu grasses with Mat grass in wet areas and Blue Couch in the drier areas. All these grasses are perennials with a summer growing period.

The object of the trials, one each at Coomera, Cooran and Moggill, on old grass pastures was to discover whether nitrogen fertilizers could be used to (a) lengthen the autumn pasture growing season for utilization in winter milk production or (b) hasten the spring pasture growing season for utilization in summer butter production. Superphosphate has been applied at Coomera and Moggill at 2 cwt/acre per annum and at Cooran at 4 cwt/acre per annum.

For the trials sulphate of ammonia was used at 1, 2, 4 cwt/acre, each applied in one, two and four applications, commencing following the first useful rain in each of the main seasons. A three-week cutting schedule was used. Where the total applications were divided into two or four parts, these were applied after each cut.

Where soil moisture was satisfactory, colour responses were noted and weighable growth recorded within 21 days of application of sulphate of ammonia. On the old permanent pastures studies, at least 2-4 cwt/acre of sulphate of ammonia are required for worth while results. With autumn topdressing, splitting the total application is a disadvantage. Nitrogen recovery in the herbage varies from 7%-49%. With summer topdressing under this season's conditions there was no advantage in splitting the total application. Nitrogen recoveries for the summer series of trials are not yet available. The problem of utilization of additional pasturage in autumn and summer is receiving attention in the form of grazing trials.

Although the results obtained have yet to be translated into actual practice, they indicate with maximum utilization of the additional pasturage sulphate of ammonia can be effectively used on some of our old permanent pastures.

Given the right seasonal conditions greatly increased amounts of pasture can be produced. When the amount of feed available is considered and related to theoretical maximum utilization by a profitable dairy cow, the following net increased returns are possible:—

Coomera (Paspalum) Potential Net Increase—£27/16/0 per annum;

Cooran (Paspalum) Potential Net Increase—£37/17/0 per annum;

Moggill (Blue Couch) Potential Net Increase—£14/13/0 per annum.

The Snowy Mountains Scheme

Mr. R. G. Barnett, Public Relations Branch, Snowy Mountains Hydro-Electric Authority in an address to the N.S.W. Branch 25/7/57.

Mr. Barnett supplemented the information in the two excellent colour films by a short address consisting mainly of further statistical details. The overall scheme which will cost £400,000,000 is expected to return £35,000,000 per annum from the sale of electricity. All water impounded is supplied to the State Governments free of charge. The Scheme covers an area of 3,500 sq. miles and consists of 3 main storages and two main tunnels of 14 and 30 miles in length. The electricity produced will be 3,000,000 kilowatt hours or double the 1949 power production. Two million acre feet of water will be available per annum. When completed, there will be 83 miles of tunnels greater than 25 ft. diameter, 8 dams, 16 power stations.

Apart from electricity the Scheme will provide irrigation water and a degree of flood control. The Scheme should be completed by 1974. The electricity produced will be mainly used to meet the peak load in the larger cities. Base load requirements are more cheaply met by thermal produced electricity while peak load requirements are best supplied by hydro-electricity. Despite the fact that no charge is made for the water for irrigation, the Authority is producing electricity cheaper than thermal power stations.

It has been estimated that of the total cost of £400,000,000, £80,000,000 will be spent in supplying the 2,000,000 acre feet of water per annum.

The Authority is responsible for the soil conservation within the catchment area and has set up a Soil Conservation Section which is studying land use and conservation methods, and has already made very worthwhile progress. Protection of embankments along the many roadways forms a large part of the work. As a result of years of burning off, erosion is quite serious in many areas. The film clearly showed the type of erosion occurring and the methods being used to combat it.

SYMPOSIA

Why Butter?

A Symposium held by N.S.W. Branch on 31st May, 1957.

Mr. Gruen spoke from his knowledge of the coastal dairying district from the Macleay River to Queensland, an area accounting for between 50 and 60 per cent. of the State's butter production. Conditions in S.E. Queensland may be similar although other Australian dairying districts may differ.

Wide differences of opinion occur concerning means of improving efficiency in the butter fat producing areas. Two conflicting statements made recently by agricultural officers were quoted to demonstrate these differences. The first statement—"The scope for increased efficiency and reduced costs of production on most (dairy) farms is enormous . . ." expresses an opinion which is widely held. The second, also by an agricultural officer, stated that "extension work has become static" through lack of research and "information to shoot out to the farmers." A recent survey, which supports this statement, revealed that of fifty farms surveyed only seven could improve the annual nett income by greater than £100 p.a. by the application of "improved methods". Mr. Gruen concluded that the gap between knowledge available and its application was not as great as commonly thought and that "the creation of bigger farms is, in my opinion, a prerequisite before attention can be paid to the use of labour on most dairy farms".

Discussing alternative production opportunities, Mr. Gruen pointed out that a mass swing to more intensive cropping with bananas, pineapples, vegetables, etc., could lead to severe price declines in those goods, with a limited market. More extensive land use such as beef production would pose social problems but could be a partial solution to the problem.

Mr. Gruen did not agree with the view that the problem is temporary and would be solved as the Australian population, and consumption of butter, increased. In conclusion, Mr. Gruen commented on certain "inefficient features" of the butter marketing system, particularly the lack of flexibility to take advantage of changing prices for various dairy products overseas.

Mr. L. J. Johnstone, Secretary, Primary Producers' Union

Mr. Johnstone contrasted the viewpoint of dairy farmers in the early days of selection and pioneering, with those of the modern farmer working on a businesslike basis.

Whereas sale of milk for human consumption is very remunerative in the milk zones of New South Wales, sale of milk for processing is not —because of small charges for production, which must be met by the producer or factory, and the unsatisfactory price.

The bulk of processed milk is exported at a price not fixed. As a result of U.S.A. export surpluses causing havoc on world markets, export returns are low. The system of selling the surplus by tender, as practised by Holland, appears a more satisfactory system.

The Australian Dairy Produce Board, which concerns itself with butter and cheese only, has recently sent a delegation overseas to attempt to stabilise the quantity of produce on the London market.

Certain types of butter, e.g. Danish, have a traditional market in the U.K. and, therefore, do not compete with Australian and New Zealand products.

Mr. Johnstone concluded that a great deal could be done to improve marketing conditions.

Dr. D. V. Lewis.

Speaking as a food technologist, Dr. Lewis considered whether butter is necesary gastronomically. Its competitor, margarine, is no longer of inferior flavour and the price differential is now quite considerable. At the moment the consumption of table margarine is comparatively low but margarine has almost completely replaced butter for cooking purposes. The Australian margarine is inferior in quality to the overseas product because the oils available, mainly cocoanut oil, are not as suitable as peanut oils, etc.

Dr. Lewis considered that a sales promotion programme could result in wider use of dairy products and that the interests of the two products could be blended to protect both industries.

The restrictions on marketing of margarine are not yet limiting but could become so if margarine consumption trends follow those in U.S.A. and the U.K.

Water Utilisation in Australia

A symposium held by the South Australian Branch with four speakers—Dr. C. G. Stephens, Dr. J. P. Quirk, Mr. J. W. Holmes, Mr. M. B. Spurling.

Dr. C. G. Stephens—Irrigation Resources of Australia.

Introduction: In terms of water resources Australia has a below average share of water per unit area. Average yearly rainfall for Australia, the World, and the U.S.A. is 16½", 26" and 29" respectively. In addition to this, the seasonal variability in flow of Australia's major rivers is great.

In terms of land resources Australia has 1½ million acres of irrigated land, and a potential of more than 5 million acres as compared with 26 million acres in the U.S.A. These figures are based on available water data. Australia has an almost unlimited supply of land for irrigation, but its disposition near to a suitable source of water, limits the actual area available. Soils which were suitably disposed near water also had a wide textural range and were not all suitable for irrigation.

Irrigation Areas of Australia

South-Eastern area. The source of water to this area is from the Great Dividing Range and the Australian Alps. Comparing two districts within the area, Berriquin and Wakool, it is evident that the value of these areas depends on the relative acreage of the lighter textured red-brown earths in contrast with the grey and brown soils of heavy texture. The former is permeable and suitable for irrigating horticultural crops and pastures, whereas the impermeable nature of the latter makes it unsuitable for most crops excepting rice.

In Queensland the land favourably disposed for irrigation is of poor quality, the most permeable soils being confined to the levee banks.

In Western Australia the irrigation areas are confined almost solely to the podsolic plains south of Perth. The winter rainfall and summer drought of the area is beneficial in keeping salinity at a minimum although rising water tables are sometimes a problem.

The horticultural areas along the River Murray in South Australia are characterised by the complex soil pattern from the viewpoint of permeability and topography. These areas require a careful control of water distribution and well planned drainage schemes to prevent overwatering which leads to salinity and water logging problems.

In Central Australia, there are limited supplies of shallow, good quality water in the aquifers of seasonal streams. The River Todd aquifer supplies Alice Springs with water for market gardens and domestic purposes. The soils in these areas are generally permeable and their development is important to the Central Australian communities.

Conclusion: The question has been asked whether it would be better to supplementary irrigate soils in higher rainfall areas, rather than extensively irrigate soils in low rainfall areas. The benefits from supplementary irrigation of the higher rainfall areas would arise because: distribution of water is more efficient, better soils are available for irrigating a wider range of crops, and winter rainfall prevents the accumulation of salts in the soil profile. Against this there is the danger of rising water tables and water logging caused by heavy winter rains.

There is need for more research and soil survey work so that future irrigation projects would be founded on a sounder basis than in the past. There is also need to accurately reassess the value of existing areas, as a basis for abandoning areas and redistributing the water where necessary.

To finance the research and survey program it is suggested that the growers contribute to a fund at the rate of one penny per acre inch of water received. The gross return of this levy would be about £200,000 per annum.

Dr. J. P. Quirk—Aspects of Water Quality in Irrigation.

The Riverina region near Deniliquin (N.S.W.) is characterized by large areas of impermeable grey brown soils of heavy texture. Establishment of pastures on these soils is a problem. Planting operations, particularly watering, result in almost complete dispersion of the soil which seriously impairs aeration. On drying the soil forms a hard crust which cracks into a regular pattern. This environment presents great difficulties to a developing seedling.

The above characteristics are associated with a high-exchangeable sodium content in the clay. The following figures are for Riverina clay which constitutes over 30% of the area of soil available for irrigation in the region.

Depth (inches)	Clay (%)	Exchangeable Na (%)
0-½	21	9
3-10	62	23
33-41	59	25

Previous work showed that to maintain soil permeability, the electrolyte concentration of the percolating water had to be kept above a certain minimum value. This value is determined by the percentage exchangeable sodium present in the soil.

In California massive applications of gypsum are added to the soil to replace the excess sodium with calcium. This can't be done in the Riverina because there are no close large scale gypsum deposits. Hence a different approach has been used. The irrigation water is adjusted to the calculated electrolyte concentration by dissolving gypsum in it. It is then applied to the soil at seeding. The idea is to keep the top layer of soil in a flocculated and permeable condition during germination and subsequent establishment. On the test plots the amount of gypsum added was 2,000 lbs. per acre foot of water. The test plant was *Trifolium subterraneum.*

Establishment counts clearly indicate the value of this treatment, being 20% and 5% on the treated and untreated plots respectively.

Mr. J. W. Holmes—Seasonal evaporation rates in the upper S.E.

Introduction: In the upper S.E. of South Australia new areas are being sown to pasture, replacing the native mallee heath. The problem is to find out how this change in vegetation will affect ground water supplies in the new areas. It is important to know this because ground water is the prime source of water for livestock.

Measuring Stored Water: The soil-water balance equation is rainfall—(soil storage + runoff) = evaporation. Runoff is negligible in the case considered so that the net amount of water stored can be calculated if rainfall and evaporation are known. Rainfall data is usually available. Evaporation can be measured directly from evaporimeters, but few areas have such records.

Energy balance and vapour transport equations can be used to calculate potential evaporation, providing the appropriate meteorological data is known. Potential evaporation only equals

actual evaporation when soil water is non-limiting. Hence it is of limited value in dryland areas where water is often limiting.

An alternative to the above is to get direct information about the amount of water stored in the soil. The neutron moisture meter measures soil moisture content and can be used to follow soil moisture as it moves through the profile. These measurements yield information on the fate of soil moisture—whether it has been evaporated, or whether it has moved deeper into the soil out of the reach of plant roots and eventually into the ground-water basin.

Experimental: The neutron moisture meter has now been used for two years in the upper S.E. One site is a mallee heath and the other an established lucerne pasture. To date it appears that both the lucerne and heath are transpiring all of the incoming rainfall and that replenishment of the ground water supplies is not from local rain. It is not yet known whether the lucerne is capable of extending its roots down to the ground-water because it is a young pasture. The measurements have only been made on two sites over a short period and no general statement can yet be made.

Mr. M. B. Spurling—Water Requirements of Horticultural Crops.

With fruit trees and vines we want to know to what extent the crop can be economically increased by augmenting the moisture supply. In the Murray Irrigation Areas irrigation water is cheap and relatively small crop increases will be economic. The grower wants to know how much water to apply at each irrigation; and how to time irrigations to meet the varying seasonal needs of his crops. The engineer wants to know the total water requirements per acre per year and the maximum channel capacity required at any time during the year.

To answer these questions we have to know the tree and vine water requirements. We want a sensitive index of moisture stress. Research on this problem has yielded a satisfactory method, viz., the use of fruit growth rate measurements as an index of tree moisture status and the use of this information to correlate free water usage with evaporation measurements. In this way the optimal length of the interval between irrigations can be expressed in terms of evaporation summation. This method has proved satisfactory with citrus, peaches, apples and grapes.

With improved facilities for irrigation frequency, the limitation on irrigation efficiency has become the method of applying the water to the land. There are also problems of the improved water regime, e.g., thick skins on oranges. However yields have improved tremendously over the last ten years and a lot of this is a result of spray irrigation and better irrigation timing.

BOOK REVIEW

BIOLOGY OF ROOT INFECTING FUNGI

By S. D. GARRETT

(*Cambridge University Press*, 1956, *pp. XI* + 293. *Price* 30/- *sterling*.)

For the past quarter of a century S. D. Garrett has made regular and notable contributions to our knowledge and understanding of the root-infecting fungi. In the process he has introduced a series of refreshingly original ideas and concepts on the ecological behaviour and evolutionary status of these fungi when considered in relation to the general soil microflora. These ideas and concepts have now been woven into the context of a book of outstanding merit which tells the story of the development of root disease investigation as a modern day science.

In presenting Biology of the Root-infecting Fungi as successor to his widely-acclaimed Root Disease Fungi, Garrett has however done much more than review for the benefit of plant pathologists one aspect of plant pathological endeavour. He has produced a probing, thought-provoking philosophical treatise which, by reason of its holistic approach to the subject integrates the interests of plant pathologists, soil microbiologists and plant ecologists. For, as the author stresses, "root-disease investigation belongs as much to the science of soil microbiology as to that of plant pathology" and "soil microbiology is but a branch of plant ecology."

In the early chapters a semi-historical review of the development of root-disease investigation as a separate aspect of plant pathological work precedes a classification of the fungus flora of the soil into ecological groups. Classified on the basis of degree of parasitic specialization, in the case of root-infecting fungi, and on the basis of substrate relationships, in the case of obligate soil saprophytes, the characteristics of the fungi belonging to each of these ecological groups are reviewed in successive chapters.

Thereafter comes a particularly interesting discussion of the effects of root-surface and rhizosphere microfloras on root infection followed by a series of three chapters dealing with the saprophytic life and behaviour of parasitic fungi. The epidemiology of root diseases and the principles of root-disease control are very adequately covered in the concluding chapters.

The value of the book, which is singularly free from errors and well produced, is enhanced by an excellent bibliography.

F. C. BUTLER.

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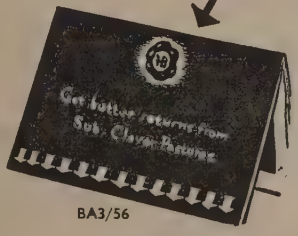

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NEWS ITEMS

Commonwealth Scientific Publications Committee

The Commonwealth Scientific Publications Fund was established by the Commonwealth Government in 1927 to provide financial assistance to meet the cost of publication of meritorious scientific works, the nature of which made it impossible for scientific organizations to undertake the cost of printing and the expenses associated therewith.

The Commonwealth Scientific Publications Committee, which was then formed to consider applications for grants from the funds placed at its disposal by the Government, now includes Mr. C. L. Hewitt (Chairman), First Assistant Secretary, Department of the Treasury, Dr. F. W. G. White, Deputy Chairman, Commonwealth Scientific and Industrial Research Organization, and Dr. H. G. Raggatt, Secretary, Department of National Development. This Committee has the power to co-opt an additional member as required on account of his special knowledge of the branch or branches of science concerned in each application.

Three essentials are necessary to secure financial assistance:—

(1) the work must be of a very high standard of merit;
(2) publication would be a distinct service to science;
(3) publication of the work is, on account of its extent, beyond the financial capacity of any of the scientific Societies or is not, on account of the probable limit on the number of purchases, acceptable to any commercial publishing house.

Since its formation, the Committee has aided the publication of Memoirs, Reports, etc., relating to the results of special investigations carried out in Australia, such as the "Study of the Meteorological Results of the First Shackleton Expedition," by Dr. Edward Kidson, "Phonetica and Grammar of the Aranda Language," by T. G. H. Strehlow, the "Geological Map of Australia," by Sir Edgeforth David, and many others.

Grants are usually made by payment of the printer's account where the financial assistance approved covers such cost, or in other cases to the author on receipt of evidence that the scientific matter has been printed.

Applications, together with complete copies of manuscript for consideration by the Committee, should be forwarded to the Chairman, Commonwealth Scientific Publications Committee, Department of the Treasury, Canberra, A.C.T.

Regional Development Survey

A study of the agricultural potential of the Southern Tablelands of N.S.W. is being made by C.S.I.R.O. in conjunction with the N.S.W. Department of Agriculture and the Agricultural Research Liaison Section.

The basic aim is to define the present agricultural situation and the scope for further development in the light of recent research. Another important result should be to reveal the need for new research work and the relative importance of each problem.

Instead of wasting manpower on a study of the whole region, the Yass River Valley has been chosen as a pilot area for detailed study before a more extensive examination is made of the whole region.

One of the first tasks to be undertaken will be a description of the physical environment in the pilot area. C.S.I.R.O. will be the main contributor in this work. Another aspect will be to hand over to the State authorities information on those research projects that have reached a suitable stage for application in the field.

The N.S.W. Department of Agriculture has begun a comprehensive farm survey to define the present pattern of primary industry in the valley.

"Plant Breeding Workshop" at Canberra

A three weeks course for Australian plant breeders was held at the C.S.I.R.O. Canberra Laboratories from 29th July to 16th August. The course, which consisted of lectures, demonstrations and seminars, covered theoretical and technical aspects of plant breeding.

Dr. O. H. Frankel, Dr. R. D. Brock and Dr. D. L. Hayman of C.S.I.R.O. dealt with methods and problems of plant breeding that occur at the chromosomal level, and Dr. F. H. Morley discussed the significance of physiology and ecology in plant breeding.

In a series of talks by Dr. J. B. Griffin, special emphasis was placed on quantitative inheritance and selection procedures while other lectures covered cytology, polyploidy, plant hormones and physiology of flowering.

Twelve plant breeders from the various State Departments of Agriculture attended the course. In addition to the set course informal discussions were held covering all aspects of plant breeding.

New Wool Carbonizing Process

As a result of research at C.S.I.R.O.'s Wool Textile Research Laboratories a method has been evolved for reducing the loss of wool during the carbonizing process to remove vegetable material.

Approximately 10 per cent. of the Australian wool clip requires removal of burrs and grass seeds and it is expected that the value of the additional clean wool obtained as a result of the new process will be of the order of £1 million.

In the normal carbonizing process using sulphuric acid 8 to 9 per cent. of the wool is lost. However, it has been found that by the addition of detergents to the sulphuric acid this damage is reduced to the extent that an additional 5 per cent. of the wool processed is recovered as clean wool.

Yarn produced from carbonized wool using the new treatment is found to be markedly stronger than yarn carbonized in the usual way.

Emergency Rainmaking Operations.

In view of the drought conditions existing in the eastern States, the C.S.I.R.O. Division of Radio Physics extended the rain-making research projects to include emergency operations over drought affected areas. This work was commenced on 18th June and was terminated on 26th July when substantial falls of rain considerably improved drought conditions.

The N.S.W. and Queensland Departments of Agriculture co-operated to the extent of specifying areas where rainfall was needed and determining priorities amongst these regions. Aircraft were supplied by the R.A.A.F. Aircraft Research and Development Unit. The Bureau of Meteorology was called upon to assist.

Within priority areas, cloud seeding with silver-iodide smoke was carried out when suitable cloud formations existed.

Cloud seeding operations were carried out in the Tamworth and Parkes districts of N.S.W. and the Darling Downs of Queensland. Although it is difficult in such work to determine the extent to which the treatment affected the amount of rain falling, there is strong evidence that the cloud seeding significantly contributed towards the rainfall recorded.

Over the Darling Downs, cloud seeding operations extended over two periods. In the first trial 1½ inches of rain were recorded in the area in which the plane operated while districts outside this area recorded only 1 inch of rain. Similar results were obtained in the second series of operations.

At Tamworth and Parkes, isolated clouds were seeded and there appears little doubt that the resulting rain was mainly due to the treatment.

With the period of emergency operations closed, the long-range experiments continue. These long-range projects are designed for statistical evaluation of the results over a period of years, unlike the emergency tests where the results are open to some doubt.

Agricultural Universities—N.S.W.

The suggestion has been made that the Wagga and Hawkesbury Agricultural Colleges might be raised to University level. This suggestion received a brief period of controversial publicity in the Sydney press.

Extension Survey—N.S.W

There is a need for closer collaboration between research workers and enterprising farmers who carry out private experiments on their own properties. These farmer experimentalists are not necessarily top-flight farm managers but they have a flair for isolating problems and the inability to rest while there is a possibility of putting something right. They should be distinguished from progressive farmers who are of more direct value to extension workers as they keep abreast of new developments and relay information to others.

Details of the work leading to these statements is described in Research Bulletin No. 1, "Social Factors in Serrated Tussock Control", recently issued by the Department of Agricultural Economics of the University of Sydney.

Briefly, this bulletin is a sociological study of the response of graziers to a major threat in two areas of the Central Tablelands of New South Wales where serrated tussock has become a serious weed.

The author, Dr. Harold Fallding, has used this situation as the background to an analysis of collaboration between farmers and research and extension agencies. Graziers are described in the bulletin as being either progressive, careful, lax, or neglectful, according to their attitude to the management of their properties. Independent of this classification are the farmer experimentalists who may or may not be progressive farm managers.

The majority of the graziers who participated in the survey had a high regard for the work of the Department of Agriculture but it was often looked on as a benefactor that operated from a remote distance. The work of C.S.I.R.O. was praised enthusiastically, even if inaccurately, as credit was often given to this organization for work done by others. Reasons for this are discussed in the bulletin.

Tractor Testing Station at Werribee, Victoria.

With the recent completion of the Tractor Testing Station at the Victorian Department of Agriculture's State Research Farm, Werribee, yet another important service to primary producers will be located at this centre. The Station was officially opened on Friday, September 13.

The testing equipment has been installed in its permanent laboratories at the Station and testing activities can now be expanded in the following directions:

1. Standard Nebraska-type tests of stock-model tractors.
2. Developmental tests of prototype tractors.
3. Testing of tractor engines.
4. Testing of small engines.
5. Tests on spark arresters, especially for tractors.
6. Tests on tractor tyres.
7. Tests on the tractive and automotive equipment of farm machinery.
8. Comparative tests on engine fuels.

The Tractor Testing Station becomes the Australian headquarters for carrying out these tests and will provide an important service both to the farming community and to the tractor industry.

The operations at the Station are under the supervision of a tractor testing committee representing the Commonwealth and the States which jointly financed the establishment and operation of the Station, and the University of Melbourne which has provided the testing staff.

Soil Science Conference

The Second Australian Conference in Soil Science was held at the University of Melbourne from 21st-27th August.

The Conference was convened for the Australian Agricultural Council by C.S.I.R.O. in collaboration with the Victorian Department of Agriculture, the Victorian Soil Conservation Authority and the University of Melbourne.

A number of specialist sessions were held on Soil Chemistry, Pedology, Soil Physics, Mineralogy, and Microbiology in addition to the General Sessions which covered a wide variety of topics related to soil science.

Delegates from all states attended the conference, further details of which will appear in the December Journal.

South Australia

Work has begun on the new building for the Division of Soils, C.S.I.R.O., in Adelaide. The building is expected to be finished in June, 1958. Then the administrative, pedology and chemistry sections of the Division in Adelaide will move in. The building, which will cost about £75,000, is located just south of the Australian Wine Research Institute, near the Waite Institute.

Deputation to Victorian Premier

On the direction of a special general meeting of the Victorian Branch, a deputation waited on the Premier to seek better conditions for agricultural scientists.

The deputation was led by Sir Samuel Wadham who was supported by Mr. V. W. Officer, Secretary of the Graziers' Association of Victoria; Mr. E. G. Roberts, President of the Victorian Dairyfarmers' Association; Mr. F. H. M. Cullen, an executive officer of the Wheat & Woolgrowers' Association; Mr. D. E. Barry Wood, President of the Northern Victorian Fruitgrowers' Association, and Mr. J. A. Roberts, Executive Officer.

Sir Samuel told Mr. Bolte that because of constant resignations of university graduates—105 in the past 12 years—efficiency could not be maintained in the Department of Agriculture. He said that the salaries paid to officers in the middle and upper ranges were unrealistic and suggested that this was particularly so in the middle range and that salaries of men in this group should be raised by about £300 per year.

Sir Samuel emphasised that the way to remedy the situation, was to reorganise the structure of the Public Service Board because, as constituted at present, the Board was inadequate to assess the salaries of graduates. He recommended that two boards, both with the same chairman, be set up—one with professional representatives, to deal with professional officers, and the other to deal with clerical and other officers. Mr. Bolte undertook to present the recommendation to Cabinet.

Although immediate results are not expected, it is felt that if we can effect this change in mechanism then we have paved the way for future requests for improved conditions to meet with greater success than in the past.

Second Biennial Conference of A.S.A.P.

The Second Biennial Conference of the Australian Society of Animal Production will be held in Melbourne from the 24th to 28th February inclusive. Full details of papers to be presented and excursions will appear in the December issue.

Meetings of International Wool Publicity and Research Executive

An increase in the amount of money to be spent on research, especially in further development of improved qualities of wool textiles, was among the decisions reached at the annual meeting of the Executive of the International Wool Publicity and Research Fund, held in London last May.

The Executive also decided upon world-wide intensification of all wool promotional activities and extension of joint promotion campaigns with the wool industry and the wool trade of the world.

The consolidation of the work of the 13 branches of the International Wool Secretariat and the Wool Bureau Inc., U.S.A., was also agreed upon.

Mr. T. G. Carter, C.B.E., M.C., Chairman of the Australian Wool Bureau, was re-elected Chairman of the Executive. Attending the meeting of the Executive in London were: Messrs. H. J. Wardell, Chairman, New Zealand Wool Board; A. Briscoe Moore (New Zealand); Dr. J. H. Moolman, Chairman, South African Wool Board; Dr. J. G. Van der Wath (South Africa); F. R. Howell (Australia).

In attendance at the Executive meeting, in reviewing the work of the International Wool Secretariat and planning activities for the next 12 months, were: Messrs. L. F. Hartley (Chairman of the International Wool Secretariat), R. G. Lund, M.B.E., and H. K. P. Wood.

Mr. Wood was elected Chairman of the International Wool Secretariat, succeeding Mr. L. F. Hartley who is returning to South Africa following his appointment as Manager to the South African Wool Board.

The Executive welcomed the considerable increase during the year in the amount of money contributed by the wool industry and the wool trade towards joint wool publicity with the Secretariat, which indicated the industry's confidence in the good work the Secretariat is doing to maintain wool's position as a most versatile textile.

The Executive, in deciding to increase the amount to be spent on research for wool, recognised that a shortage of scientists and research workers restricted advances in several fields and agreed that work could be carried out in commercial research laboratories.

Asian Markets for Australian Wool

There is a growing market for Australian wool in Asian countries. Japan is now the second largest buyer of Australian wool having purchased 191 million lbs. in 1955-56 and being expected to take about 250 million lbs. in the year 1956-57.

During the year 1955-56 Japan's wool consumption rose by 36 per cent. compared with a world average increase of 8 per cent. The country has some of the most modern textile mills in the world in operation.

In addition to Japan, China, Formosa and India are all increasing their annual consumption of wool for textile manufacture.

News from F.A.O., Rome

Retirement of Veterinarian

Sir Thomas Dalling, Senior Veterinarian of the Food and Agriculture Organisation, United Nations, retired recently at the age of sixty-five.

Sir Thomas is a Veterinarian of world standing. His previous appointments had included Professor of Animal Pathology at Cambridge, Director of the Ministry of Agriculture Veterinary Laboratory at Weybridge, England and Chief Veterinary Officer of Great Britain.

While with F.A.O. Sir Thomas Dalling played an important part in the establishment of international methods for the control of disease. He was largely responsible for the rinderpest eradication work of F.A.O. and also for the progress made in the European control of Foot and Mouth disease.

Rinderpest control

A world famous virologist from Japan, Dr. Junji Nakamura, is at present in Nigeria on an F.A.O. assignment to investigate the possibility of producing rinderpest vaccines for the various breeds of cattle in that country.

Dr. Nakamura, who is Director of the Nipon Institute for Biological Science, has been responsible for successful immunisation campaigns in a number of Asian countries where rinderpest was present. He has also carried out research on fowl plague, Newcastle disease and encephalitis in goats.

New Laboratories in Queensland

New Sugar Bureau Headquarters. The Bureau of Sugar Experiment Stations, which was part of the Department of Agriculture and Stock from its inception in 1900 until 1951, was removed from Departmental jurisdiction in that year and has since been controlled by a Board. The Minister for Agriculture is Chairman of the Board, the Under Secretary Deputy Chairman, and the millers and growers appoint one member each. Removal from the Government service meant removal from Government buildings, and the Bureau is now planning new headquarters. They will be on a one half acre corner block on Gregory Terrace opposite the Brisbane Girls' Grammar School.

The building will be two-storied in concrete and glass externally with substantial basement space and with a quarantine glasshouse on the roof. It will be in the form of an L with one wing facing the Terrace and the other one overlooking Parish Street. Air-conditioning will be installed and the interesting internal features include a constant temperature room for instrument standardization, a dark room, and up to the minute soils and pathology laboratories. All executive and office accommodation will be on the top floor while the laboratories will be behind the entrance foyer on the ground floor.

New C.S.I.R.O. Laboratory. A tender has been accepted for the construction of a laboratory for C.S.I.R.O. to be situated next to the new Queensland University, on a four acre block at the junction of Mill Road and Carmody Road, St. Lucia. The builders are E. S. Clementson (Qld.) Pty. Ltd., and the building will be completed by the end of 1958 at a cost of approximately £120,000. Most of the project is being financed by the Commonwealth through the C.S.I.R.O. works allocation, but important contributions are being made by the State Government. These include £15,000 and the provision of the site, roadwork and drainage

Accommodation will be provided in the new building for a staff of sixty including twenty-five research officers. The laboratories, service areas and offices cover 29,000 square feet divided into ninety rooms. A brick basement houses essential services, over which is the main laboratory block; opposite the basement will be 4,000 square feet of glasshouses for plant experiments. The completed project will give excellent facilities for a wide variety of work.

The laboratory will contain personnel of the Divisions of Plant Industry and Soils, whose numbers in Queensland have increased over the last few years. Since 1949 they have occupied University Buildings, first at St. Lucia and since 1951 at George Street.

The construction of this building was first mooted in 1939 when it was decided that a laboratory was urgently needed in Queensland to investigate the agricultural problems of the grazing industry. The matter lapsed during the war, but after 1946 the negotiations were resumed and Miinsterial approval was obtained for the erection of the building. However the project was not commenced because of a reduction in the money available for building construction and it was not until 1954 that Messrs. Hennessy and Hennessy, the University architects, were commissioned to draw preliminary plans. The project reached detailed design in 1956; finance became available in the 1956/57 financial year, and building operations were commenced at the end of July.

Visiting Scientists

Professor R. M. Lowe, Professor of Agronomy at the University of California, who has been studying in New Zealand as a Fulbright Scholar, visited agricultural organisations in Australia during June before returning to the United States. During this time he spent several days at the Canberra laboratories of C.S.I.R.O.

Mr. Ayyub Shaikh, an F.A.O. Fellow from Pakistan who is based at Canberra with the Plant Introduction Section, visited Queensland during May and June. As well as meeting members of the Plant and Soils Laboratory he had discussions with the staff of the University of Queensland and officers of the Department of Agriculture.

Mr. H. D. L. Carby, an F.A.O. Fellow from Rhodesia, is spending some time working at C.S.I.R.O. centres on legume production

U.S. Tobacco and Extension Specialist's Visit

Dr. Roy R. Bennett, Agronomy Extension Specialist (Tobacco) of North Carolina State College, Raleigh, spent 27-30th May in Queensland as the last stage of a three-month tour of the tobacco producing areas of the world. While on tour, Dr. Bennett made observations on the behaviour of tobacco varieties, such as Harrison Special, which originated in North Carolina, and investigated in some detail the advisory services

used by various Departments of Agriculture to acquaint tobacco growers of the latest advances for improving production.

While in Queensland Dr. Bennett attended a meeting of the Tobacco Leaf Marketing Board, a session of a Tobacco Advisory Officers' Conference, inspected the South Queensland Tobacco Growers' Association selling floor, visited the Inglewood Tobacco Experiment Station and farms in the surrounding tobacco growing area.

In comparing tobacco production in Queensland with that in North Carolina, Dr. Bennett said that soils and cultural operations were similar in many respects but problems were somewhat different. North Carolina, for instance, has no blue mould trouble once the plants are in the field.

On the evening of 20th May, Dr. Bennett addressed a well attended gathering of the people directly concerned with tobacco production in Queensland, and to stress the magnitude of the extension service under his control mentioned that each of the 120,000 North Carolina tobacco farms was identified by a registered number and these farms were worked by 350,000 growers. A field day would frequently draw an attendance of 5,000, usually four or more sessions were necessary on such days to enable this number to be handled effectively even using "bull-ring' methods. Farm tours were popular with growers as a means of demonstrating advanced methods adopted by their more progressive neighbours.

BOOK REVIEW

THE FRIENDLY FUNGI

By C. L. DUDDINGTON

(*Faber and Faber, London,* 1957, 21/- *stg.*)

Many accounts have been written of the continual struggle for existence in nature, and we are all familiar with the way in which the various forms of animal life prey upon one another. Practical application of this knowledge has enabled us to achieve biological control of many crop pests. In this book, we are reminded that the same struggle for existence goes on amongst the micro-organisms in the soils of our farms and gardens. The author, an expert on predacious fungi, explains how this may possibly be used to our advantage in the control of plant diseases caused by eelworms.

The habits of a number of species of predacious fungi are described, and the often remarkable mechanisms they use in catching their prey, the eelworm, are illustrated by the use of some excellent photographs and line drawings. A general account is also given of some of the plant diseases caused by eelworms, and some of the problems related to their control are discussed. The great losses being caused by eelworm diseases of various crops is emphasised. For example, it is estimated that the potato root eelworm causes £2,000,000 worth of damage to potato crops in the U.K. alone. It is suggested that predacious fungi may offer a means of biological control of these eelworm parasites, and the results of some experiments using predacious fungi in this way are reported.

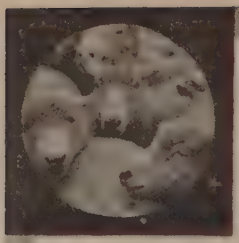
The idea of using soil organisms to control parasitic eelworms is not a new one, and although the author reports some measure of success, he readily admits that a great deal has yet to be learned before the method can be applied most effectively. It is, however, another approach to an increasingly important problem and one which must be further investigated.

It is interesting to note the speculation that the increase in importance of plant diseases caused by eelworms appears to be related to a corresponding decrease in the use of compost and organic manures. Compost and decaying organic material are rich in predacious fungi which would assist the arguments put forward in favour of organic farming.

Appendices on techniques used in the collection, cultivation and examination of predacious fungi are added, together with a useful bibliography on the subject.

The book is written in a non-technical style which is aimed to interest a wide circle of readers, but it should be of particular interest to those who are concerned with plant diseases or soil microbiology.

J. W. MEAGHER.



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INSTITUTE AFFAIRS

PERSONAL NOTES

Australian Capital Territory

Dr. P. S. Nutman, who recently returned to the U.K. after spending a period with C.S.I.R.O. at Canberra, has been appointed as Head of the Soil Microbiology Department at Rothamsted Research Station.

Mr. L. F. Myers has been appointed Officer-in-Charge of the C.S.I.R.O. Regional Pastoral Laboratory, Deniliquin. He was previously with the ecology section in Canberra.

In May, the Division of Land Research and Regional Survey, C.S.I.R.O., examined a transect of country from Darwin to Mt. Cavanagh in the Northern Territory. The traverse covered country ranging from about 60 inches rainfall in the north to about 6 inches in the south with a wide variety of climatic and land types with a view to defining practical ecological and hydrological problems for further study. *Messrs. C. S. Christian, G. A. Stewart, R. A. Perry, R. O. Slatyer* and *J. A. Mabbutt* participated in the traverse.

The mainland survey unit of the Division this year is completing field work in the Alice Springs region. *Mr. R. A. Perry* is in charge of the survey unit.

Mr. G. A. Stewart recently spent 3 weeks in the field with the New Guinea survey unit of the Division. This year, under leadership of *Mr. H. A. Haantjens* the unit is working in the Eastern Highlands of New Guinea.

Mr. W. R. Stern, of the C.S.I.R.O. Katherine Research Station, has been granted leave of absence to undertake work for a Ph.D. degree at the Waite Institute under the direction of Professor C. M. Donald.

Mr. A. L. Chapman of the Kimberley Research Station, W.A., is proceeding overseas on leave in August. He is planning to visit the United States, Malaya and other centres to examine the latest developments in research on rice.

Mr. C. Rossetti, a holder of a UNESCO fellowship, arrived in Australia in July to undergo 6 months' training in regional survey methods and arid zone research with the C.S.I.R.O. Division of Land Research and Regional Survey.

Mrs. R. Gani, who was at one time Dr. Frankel's personal research assistant, spent a week at the Canberra Laboratories renewing her interest in the work of the Genetics Section. Mrs. Gani, who now lives in Perth, has recently returned from England.

Mr. J. R. Lambourne, a recent appointee to the Division of Animal Health and Production who is working on the animal side of pasture utilisation at Armidale, spent some time in Canberra with the Agronomy and Biochemistry Sections.

Mr. D. Wimbush, a graduate in botany and zoology of the University of Sydney, has been appointed as a Technical Officer to assist in the programme of research into the ecology of the catchment area of the Snowy Mountains Hydro-electric Scheme. For the past six months he has been assisting Mr. A. Costin at Island Bend where he will now be stationed permanently.

New South Wales

Dr. R. J. Noble, Under Secretary and Director of the N.S.W. Department of Agriculture, received the honour of Commander of the Order of the British Empire in the Honours announced in the Queen's Birthday list.

Mr. A. Pearson has been appointed Chief of the newly formed Division of Experiment Farms and Stations in the N.S.W. Department of Agriculture. Mr. A. C. Orman has been appointed Deputy Chief, Division of Plant Industry.

Mr. H. Parry-Brown, Chief, Division of Information Services, has attended the "International Study Course in Programme Planning in Agricultural Extension Service" and is visiting England and the United States to study extension methods.

The degree of M.Agr.Sc. has been conferred on *Mr. N. J. Barrow* of the C.S.I.R.O., Armidale, by the University of Melbourne.

Fifty-six second-year students at the Faculty of Agriculture, Sydney University, attended a two weeks' practical agriculture training course at Wagga Agricultural College and Experiment Station during which an inspection of the research work in progress at the Agricultural Research Institute was made.

Three scholarships have recently been awarded. *Mr. K. S. McWhirter,* Maize Breeder, has received the Sir Benjamin Fuller Research Scholarship for future study of genetics of maize, probably at Wisconsin University.

Mr. K. Marshall has been awarded a Fulbright Travel Grant to attend Cornell University for a period of three years to study soil microbiology. *Mr. D. Munns* has been awarded the Thomas Lawrence Pawlett Scholarship to study at the University of California.

Miss A. Gregory is travelling to England. *Miss B. Barnett* and *Miss S. Kemeny* have accepted positions with the C.S.I.R.O. Wool Biology Laboratories at Prospect.

Mr. W. J. Scott, a senior member of the C.S.I.R.O. Division of Food Preservation and Transport at Homebush, and a world authority on food bacteriology, has submitted a thesis on the physiology of micro-organisms which has been accepted by the University of Melbourne for the degree of D.Sc.Agr. to be conferred later this year.

Professor G. F. Stewart, Professor of Poultry Science at the University of California, is visiting Australia with the assistance of a Fulbright Grant to study the poultry industry in this country. Professor Stewart, who is a world

authority on poultry science, is at present a guest of the C.S.I.R.O. Division of Food Preservation and Transport at Homebush, where he is conducting research on the functional properties of dried eggs.

Professor J. N. Lewis has recently been appointed Professor of Agricultural Economics at the University of New England. Professor Lewis was formerly Assistant Secretary at the Department of Trade, Canberra and was a member of the A.C.T. Branch.

Mr. L. J. Lambourne has recently joined the staff of C.S.I.R.O. Armidale as an Animal Husbandry Officer. Mr. Lambourne came to Armidale from Ruakura Research Centre, New Zealand, where he spent some years on research work and published several papers.

It is pleasing to note that fourteen (14) students in the second academic year in the Faculty of Rural Science, University of New England, have applied for student membership of the Institute. It is hoped that these and subsequent students will swell the ranks of Institute members in the north of New South Wales, to the benefit of themselves and the Institute.

Victoria

Messrs. *G. Bath, A. Mann* and *D. G. Meadley* recently spent some time in Canberra discussing proposals for a survey of the wheat industry with officers of the Bureau of Agricultural Economics.

Messrs. *P. Pryke, P. Debrett* and *Miss G. Hotton* attended the Plant Breeding Workshop held at the C.S.I.R.O. laboratories in Canberra during August.

Queensland

Mr. C. S. Andrew of the Plant and Soils Laboratory, C.S.I.R.O., has been awarded a Rockefeller Foundation Fellowship for twelve months' study in the U.S.A., commencing in September this year. Mr. Andrew will spend ten months at Cornell University working on plant nutrition with *Drs. Bradfield, Peech* and *Brady*. The remaining two months will be taken up visiting selected laboratories in the States, and he hopes to return home via England and Holland.

Mr. W. A Smith, Entomologist, Department of Agriculture and Stock, lately stationed at Nambour, left Brisbane on May 12th on his way to the United States. Mr. Smith will travel first to the Texas Agricultural Experiment Station, College Station, Texas, and expects to be away from Australia for about six months, most of the time in Texas. The purpose of the trip is the location and collection of an insect which it is believed may be useful in helping to control Noogoora burr in Queensland.

Mr. W. Fox has been appointed lecturer in Soil Physics in the Agriculture Department of the University of Queensland, where he will continue his work with the Darling Downs black soil.

Mr. R. B. Morwood is investigating plant disease problems for the U.S. Trust Territories of the Pacific Islands. This is a short term project on taro, breadfruit and other crops. Mr. Morwood's work will be in the Marshall, Mariana and Caroline Islands.

A recent visitor to Brisbane was *Mr. A. Sankaran.* Mr. Sankaran had just spent some fifteen months in New Zealand studying factors affecting the efficacy of commercial cultures of legume bacteria. In Australia he has been visiting Rhizobium workers and hopes to commence research work on this subject, and the distribution of legume bacteria to farmers, on his return to India.

On July 24th, *Mr. W. J. S. Sloan* left Brisbane for the U.S.A. on a Rockefeller Foundation Travel Grant. Mr. Sloan, Director of Agriculture, Department of Agriculture and Stock, will return to Australia late in December. In the intervening five months he will visit agricultural centres in Washington, Nebraska, Ohio, Washington D.C., North Carolina, Texas, Arizona, California and Hawaii. The parts of agriculture receiving most attention are land organization, conservation of fodder, extension methods, irrigation, dry land farming practices, and crop rotation.

An interesting visitor present at our June meeting was *Mr. Frank Thomas,* livestock officer in the new West African State of Ghana. Mr. Thomas is a graduate in agriculture from London University. In Ghana, he organises the work of three Research Stations and is responsible for livestock extension work. On the non-professional side he had an interesting career as an R.A.F. pilot with two operational tours to his credit. He is in Australia on three months' annual leave at present.

Dr. H. E. Young has joined the Bureau of Sugar Experiment stations as Senior Physiologist. He has been in Ceylon for seven years where he was Director of the Rubber Research Institute, which is financed by Ceylon's 670,000 acre rubber growing industry. Prior to going to Ceylon he was Plant Pathologist in the Department of Agriculture and Stock and later Senior Weed Control Officer. Dr. Young is a foundation member of the Queensland branch of the Institute and obtained his D.Sc.Agr. degree in 1942 at the University of Queensland for his work on "Fused Needle Disease" of Pinus, in connection with his work on the forestry problems of the Wallum areas. After going to Ceylon as Oidium Research Officer and Senior Mycologist to the Rubber Research Institute, Dr. Young developed a successful control for leaf mildew of rubber which was then a serious problem in the East. In 1951 he was by invitation appointed Director of the Institute, which position he has now vacated. During his sojourn in Ceylon he travelled widely in Indonesia, Malaya, India and the United Kingdom.

South Australia

Dr. N. T. Flentje returned to work at the Waite Institute in August after his overseas study trip.

Mr. E. D. Carter, formerly officer-in-charge at Parndana on Kangaroo Island has been appointed senior research officer in Agronomy with the Department of Agriculture.

Dr. C. G. Hansford has received an invitation to visit the Institute of Micrologia, University of Recife, Brazil, during 1958.

Dr. K. W. Finlay will attend the International Genetics Congress to be held in Montreal in 1958. He will travel via the U.K. and the U.S. to study cereal breeding.

Dr. J. N. Black will go to Europe in 1958, visiting Oxford and the Royal Agricultural College, University of Upsala, in Sweden.

In connection with the A.N.Z.A.A.S. Congress to be held in Adelaide in 1958, local committees for Section K will be *Prof. C. M. Donald* (chairman), *Messrs. G. Blackburn* and *J. Thomas* (secretaries), *Dr. A. R. Callaghan, Messrs. B. H. Bednall, A. G. Strickland, Dr. C. S. Piper, Messrs. J. W. Holmes, W. G. Allden* and *Dr. K. W. Finlay*. For Botany (Section M) *Prof. Wood* (chairman), *Mr. H. B. Womersley* (secretary), *Drs. S. P. Riches, R. L. Specht, C. G. Hansford, L. H. May* and *Jean Mayo*. For Section I (Microbiology) *Dr. R. J. Best* (chairman), *Dr. H. Gilmore* and *Mr. J. May* (secretaries), *Dr. R. J. Swaby* and *Dr. B. S. Hetzel*. Drs. Melville and Best are on the Organising Committee of the Congress. *Dr. Best* is Chairman of the Hand Book Committee.

Western Australia

Professor E. J. Underwood, Director of the Institute of Agriculture, Crawley, left in June for six months' study leave in America. He has obtained a grant from the Carnegie Corporation in New York and will visit a number of leading Universities and Agricultural Research Institutions to enquire into the administration and financing of graduate training, and research. During his visit he will attend several conferences associated with trace element problems, particularly those most concerned with the soil-plant-animal relationship.

Mr. C. Hale, a Research officer, has been granted 12 months leave from the Department of Agriculture. Early in July he left for the University of California where he has been offered a position as Research Assistant in the Department of Viticulture.

Mr. R. G. Mauldon of the University Institute of Agriculture left late in July for the Iowa State College of Agriculture where he will continue further studies in production economics under Prof. E. O. Heady. He expects to be away for about 3 years.

Mr. R. F. Doepel, a Plant Pathologist in the Department of Agriculture, left for England early in April on 6 months' long service leave; he intended to spend 2 months at Long Ashton Research Station working with Mr. Marsh, a world authority on fungicides. Mr. Doepel will investigate the recent developments in fungicides and fungicidal application. He will later visit research centres at East Malling, Rothamsted and possibly Scotland and Northern Ireland.

Mr. E. W. Boehm, a member of this Branch, has transferred to South Australia. Mr. Boehm engaged in farming at Kendenup since his graduation in 1946, and has now taken up a position in the South Australian Department of Agriculture.

Mr. N. McNeil who has been engaged in farming activities in the Waroona district for a number of years has been appointed as an Adviser in the Dairying Division, Dept. of Agriculture, and is stationed at Waroona.

Mr. G. R. Grewar was, earlier this year, transferred to the Esperance district as Adviser in the Wheat and Sheep Division, Dept. of Agriculture. He has taken over from *Mr. C. M. Ralph*, who resigned from the Department to take up farming near Scaddan, north of Esperance.

Dr. H. G. Neil, the Dept. of Agriculture's District Officer at Moora, has spent most of this year in parts of New South Wales, Victoria and Queensland to attend the Sheep & Wool Officers' Extension School.

Mr. L. C. Lightfoot, who, for a number of years, was the Assistant Commissioner of Soil Conservation in the Dept. of Agriculture, has been appointed to the position of Superintendent of Soils Division (and Commissioner of Soil Conservation).

Mr. J. Parish, previously with the Research Division in the Department, has taken up duties in the Cereal Laboratory, Wheat & Sheep Division, Department of Agriculture.

Tasmania

G. C. Wade received his D.Sc. at the University of Tasmania's Commemoration Ceremony on May 15 last. This year he was also awarded a Commonwealth Fund of New York Fellowship. As a result he sailed from Sydney on July 12 in the liner "Oronsay" for San Francisco. He will spend a year in the U.S., mostly at Berkeley, California, studying host-parasite relations with particular reference to histological methods for studying fungal infections on fruit skins. He hopes to spend a further four months touring research institutions in England and the Continent. (We are not sure that the Mozart Festival at Salzburg comes into this category, but are assured that it lies conveniently between two institutions of a more agricultural nature!) Mrs. Wade will travel to America in April next year and will accompany Dr. Wade on his British and European tour. They will return in November 1958.

Mr. J. R. Ward has been appointed Officer-in-Charge of the Plant Pathology Division of the Department of Agriculture in Tasmania during Dr. Wade's absence.

Mr. and Mrs. Phillip G. Williams have also left for America. Mr. and Mrs. Williams have been awarded Research Assistantships in the University of Wisconsin. Mrs. Williams (formerly Barbara Carne) will be working on the pathogenicity and genetics of Venturia inaequalis, the fungus causing black spot of apples. Mr. Williams will study the control of development of obligate parasites. They travelled to Wisconsin via Panama and Boston. They plan to stay in America about a year and then go to England. Altogether they plan to be away for about three years.

BRANCH NOTES

Australian Capital Territory

During the current year the Branch has selected the theme "Water in Australian Agriculture" on which to base a programme of lectures and activities.

On 16th May, Mr. W. W. Mansfield addressed a meeting on the subject of "The reduction of evaporation from water storages by surface films."

At a meeting held on 14th June, Dr. E. G. Bowen spoke on "Rainfall—Natural and Artificial". Summaries of these addresses appear in the Talks section.

New South Wales

Two ordinary general meetings have been held recently. At the meeting on the 31st May, the President, Dr. Reid, and 26 members and visitors attended. The main business of the evening was a symposium entitled "Why Butter?" The three speakers invited to lead the symposium were Mr. L. J. Johnstone, Secretary, Primary Producers' Union, Mr. F. G. Gruen, Division of Marketing and Agricultural Economics, N.S.W. Department of Agriculture, and Dr. D. V. Lewis of Henry Lewis & Sons Pty. Limited. Lively discussion followed the introduction of the subject by these speakers.

The meeting held on 25th July was arranged jointly with the Australian Society for Animal Production, N.S.W. Branch, and a total of 56 members and visitors attended. At the meeting, Mr. R. G. Barnett of the Public Relations Branch of the Snowy Mountains Hydro-Electric Authority delivered a short address and screened two excellent films; one dealing with the scheme in general and the other with special aspects of soil conservation in the catchment area. The subject proved of considerable interest to all, as indicated by the number and variety of questions directed to Mr. Barnett at the conclusion of the film. Mr. Barnett readily supplied the further details requested and satisfactorily and completely answered practically all the questions raised.

Branch members are being kept advised of important current activities and developments by means of the newsletter which records notices of meetings, positions vacant, summaries of talks, council minutes and other items of interest.

The Branch has been informed that the possibility of establishing a New Guinea Sub-Branch is being investigated by a member stationed in New Guinea.

Victoria

The 22nd Annual General Meeting of the Branch was held at the School of Agriculture University of Melbourne on 31st May. The following Office bearers were elected for 1957-8.

President—*Mr. T. S. Bellair.*

Vice President—*Mr. W. B. Mackie.*

Honorary Secretary—*Mr. K. D. Woodyer.*

Honorary Asst. Secretary—*Mr. W. Parsons.*

Honorary Treasurer—*Mr. L. C. Jones.*

Committee members—Messrs *A. L. Tisdall, A. W. Stewart, J. P. Brien* and *R. E. Loder.*

Past President—*Mr. C. E. Cole.*

Honorary Sub-editor—*Mr. J. J. Walker.*

Ex-officio Professor of Agriculture—*Prof. H. C. Forster.*

The retiring President *Mr. C. E. Cole* delivered his Presidential address entited "A review of Victorian Horticulture".

Queensland

The Queensland Branch recently adopted the practice of spending some time on general discussion of Institute affairs at the beginning of each Branch Meeting. This procedure was introduced because of the increasing scope and importance of federal activities of the Institute, and the need to give members an opportunity to voice their opinion of Institute policy.

The main business of the Branch Meeting held in May was an address by *Professor D. A. Herbert,* Professor of Botany at Queensland University. Professor Herbert's talk, entitled "Botanical Observations in Europe", was illustrated by an excellent series of colour slides. The speaker's impressions of England, Ireland and Holland were described through the eyes of a discerning traveller. A feature of this meeting was the presence of a large audience consisting of 47 members and 12 visitors.

The June Meeting was devoted to three short papers given by Messrs. *V. J. Wagner, F. R. From* and *A. J. Hegarty.* Mr. V. J. Wagner (Department of Agriculture and Stock) outlined the history and the use of Russian Comfrey (*Symphytum peregrinum*) as a fodder plant, and described the results obtained in Queensland from a quarantine planting of three strains at Redlands Experiment Station. In the second paper Mr. F. R. From (University of Queensland) discussed a series of incubation studies carried out with a black earth from the Darling Downs, and compared the results obtained with the quantity of nitrogen required for the wheat crop. The third talk was given by Mr. A. J. Hegarty (Department of Agriculture and Stock) who spoke of the use of ammonium sulphate fertilizer to extend the growing season of dairy pastures in South East Queensland.

South Australia

In June, the South Australian branch combined with the S.A. branch of the Royal Geographical Society to hold the monthly meeting. *Mr. C. S. Christian,* of C.S.I.R.O.'s Land Research and Regional Survey spoke on "Recent

Developments in Relation to Land Use in Northern Australia."

In July, the meeting consisted of a symposium organised by the branch on "Water Utilisation." There were four speakers to introduce the topic. These were *Dr. C. G. Stephens, Dr. J. P. Quirk, Mr. J. W. Holmes* and *Mr. M. B. Spurling.* Dr. Stephens spoke on "Irrigation Resources of Australia," Dr. Quirk on "Aspects of Water Quality in Irrigation," Mr. Holmes on "Seasonal Evaporation Rates in the Upper South-East of S.A." and Mr. Spurling on "Water Requirements of Horticultural Crops."

Western Australia.

May Meeting.

The meeting on May 31st was held jointly with the W.A. Branch of the Australian Society of Soil Science. *Dr. D. P. Drover,* Lecturer in Soil Science at the University of W.A. spoke on "Soil Research in Scotland." Whilst on study leave, Dr. Drover spent 12 months at the Macaulay Institute for Soil Research at Aberdeen. He worked for some time on the use of radioactive isotopes in soil research and discussed a particular study associated with the effect of iron on phosphate availability.

During the talk it was pointed out that the Macaulay Institute's activities cover many aspects of soil research, including soil classification and mapping, microbiology and forestry. The Institute also houses one of the most important spectro-chemical sections in Britain and in addition it includes advisory services in its programme. Each year more than 10,000 soil samples are analysed for lime, potash and phosphate content.

Dr. Drover's talk was supported by colour slides of the Macaulay Institute, Rothamsted, and agricultural features and scenes of the Scottish countryside.

July Meeting:

At the meeting on 12th July, the guest speaker was *Professor J. W. Lugg* of the Biochemistry Department at the University of W.A. His subject was "Some aspects of Malayan Agriculture."

Before his present appointment, Prof. Lugg spent eight years at the University of Malaya. Prior to that he was engaged on plant biochemistry and general nutritional research in the C.S.I.R.O. at Adelaide and at Melbourne University. Whilst in Malaya he was a member of the Singapore Advisory Bureau of Nutrition.

During his talk Prof. Lugg emphasised the difficulties of catering for the Singapore market due to the presence of Chinese, Malays and Indians with their different social, religious and eating habits.

The soils of the Malayan peninsula, contrary to first impressions, were very poor. Although mainly clay soils they were very porous and were unsuitable for rice growing. About half the rice, the basic carbohydrate in the diet had to be imported from the surrounding islands and countries such as Siam (Thailand). Scattered areas of better soil types do occur; for example the soil near the North East coast was moderately fertile.

For many people in the Malay States, fish formed the main protein supplement in the diet and the fishing industry provided employment for many. Large quantities of dried fish were, nevertheless, imported from Java.

The production of rubber was the only real exporting industry. Most rubber was now grown on large plantations, although there were still a few small holdings. Synthetic rubber now constituted such a threat to the natural product that Malaya's economic future must surely be affected.

During discussion Prof. Lugg indicated that although each State Department of Agriculture had experiment stations, there was a dearth of true research. The threat from synthetic rubber now made research a real need.

The talk was very well illustrated with both colour and black and white slides.

Tasmania

Tasmanian members were denied the opportunity of discussing the proposal for a faculty of Agriculture in Tasmania as the University Committee set up to examine and report on the proposal decided to forward its case to the Commonwealth Committee of Enquiry into Australian Universities immediately. The Branch Committee was disappointed in the way that the University handled the matter, but was on the whole pleased with the actual submission. It has been recommended that a Faculty of Agriculture be established in the University of Tasmania and that it be built up over a period of 4 to 5 years. Capital cost was estimated at £95,000 and annual running costs £17,500. Running costs to be added to associated faculties was estimated at £23,000 annually.

During a survey conducted by the Tasmanian Branch Committee, of the salaries of graduates and diplomates employed by the Tasmanian Department of Agriculture, it was discovered that the average salary of 20 diplomates who have received their diplomas in the last seven years was £1,426. The average salary of 18 graduates who received their degrees in the last seven years was £1,329.

Also, noted in the last journal (page 179) an advertisement for an Assistant Horticultural Officer, starting salary £1,062 for a qualification of either a degree or diploma. The fact that a diplomate requires three years extra study before obtaining a degree is overlooked.

BOOK LIST

Notice has been received that the following books on agricultural topics have been published recently:—

AUSTRALIA. AGRICULTURAL ECONOMICS, BUREAU OF.—The Australian sheep industry survey: The high rainfall zone, March, 1957. Western Australia, April, 1957. Not for sale.

COMMONWEALTH ECONOMIC COMMITTEE.—Vegetable oils and oilseeds: Summary of figures of production, trade and consumption, 1956. 5/- stg.

DUNGAN, George H., and ROSS, W. A.—Growing field crops. *New York, McGraw-Hill,* 1957. $4.

MARKET MILK WEEK CONFERENCE, *Massey Agricultural College.* Proceedings, 1956. 5/-.

NEW ZEALAND GRASSLAND ASSOCIATION. Proceedings of the 18th conference, 1956. 15/-.

NUFFIELD FOUNDATION, LONDON. Farming advisory services in North America. Report of a mission to Canada and the United States of America, June and July, 1955. *London, Nuffield Foundation,* 1956. 4/6 stg.

VICTORIA. AGRICULTURE, DEPT. OF. Farm survey research branch. A study of farm management in the Victorian poultry industry: by D. R. Meadley. Not for sale.

WADHAM, Sir Samuel. Selected addresses—with a biographical study by Geoffrey Blamey. Melbourne, 1956. (Price not known.)

WATSON, James A. S., and MORE, James A. Agriculture: The science and practice of British farming. 10th ed., rev. and enl. *Edinburgh, Oliver and Boyd,* 1956. 31/6 stg.

WHITE, Gilbert F., ed. The future of arid lands. Papers and recommendations from the International Arid Lands Meetings, *Washington, American Assoc. for the Advancement of Science,* 1956. $6.75.

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In the "Monkey" Grubber way clearing work is done expeditiously and without great outlay, leaving land ready for mechanical tilling. The machine delivers 260 times the power applied to the handle. It is portable and fitted with an automatic lowering gear, second speed, rope shortener, snatch block, etc. Cable equipment is generous and comprises 180 feet in four lengths each fitted with special labour and time-saving couplings. Takes an acre and a half from an anchor.

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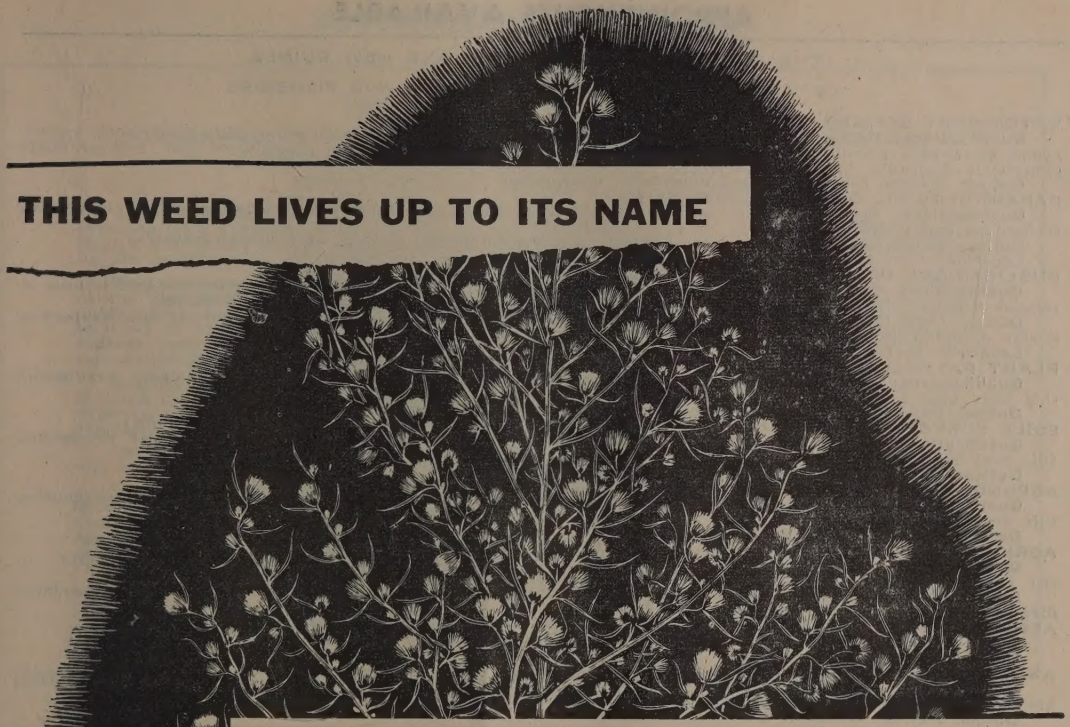
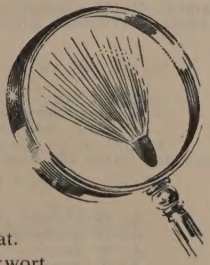


If ever there's a well-named weed it's Stinkwort.

Look at a Stinkwort flower under a magnifying glass and you'll find its petals covered with fine hairs, barbed and feathered like an arrow.



These find their mark in the stomach and intestines of livestock. Fatal diseases, such as Pulpy Kidney in sheep, set in; death sometimes occurs without any apparent cause. Even if the weed does not kill stock, it taints milk, cream and meat.

Several control measures have been tried for Stinkwort. Scientists have found that it shrivels under a hormone spray weedkiller* supplied by Shell. This weedicide kills the Stinkwort, but when used correctly does not harm established grasses, crops or livestock.

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APPOINTMENTS AVAILABLE

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DEPARTMENT OF AGRICULTURE, STOCK AND FISHERIES

VETERINARY OFFICER, Grade 1, £1,153-£1,693 p.a. (2 positions).
Qualifications: Degree in Veterinary Science or equivalent (students graduating this year may apply): sound knowledge principles disease control, animal husbandry, quarantine procedures and post-graduate experience desirable, but not necessary.
Duties: Disease control, animal husbandry, quarantine.

PARASITOLOGIST, Grade 2, £1,783-£1,973 p.a.
Qualifications: Degree in Veterinary or related Science, or equivalent; knowledge standard laboratory techniques and procedures.
Duties: Experimental and diagnostic work; provide diagnostic service for pastoral industry.
Location: Port Moresby.

PUBLICATIONS OFFICER, £1,918-£2,083 p.a.
Qualifications: Leaving Certificate or equivalent, preferably with Degree or Diploma in Agricultural or related Science; literary ability and experience editing agricultural and pastoral publications.
Duties: Collection and preparation data for Agricultural Gazette, bulletins, pamphlets, etc.; supervise stocks of publications.
Location: Port Moresby.

PLANT PATHOLOGIST, Grade 1, £1,153-£1,693 p.a. (see also under "Salary").
Qualifications: University degree, preferably with major in Plant Pathology. (Students graduating this year may apply.)
Duties: Experiments in plant pathology and control plant diseases.

SOILS SURVEY OFFICER, Grade 1, £1,153-£1,693 p.a. (see also under "Salary"). (2 positions.)
Qualifications: Degree in Agricultural Science; major in Soil Science desirable. (Students graduating this year may apply.)
Duties: Soil surveys, prepare maps and co-relate data.

AGRONOMIST, Grade 1, £1,153-£1,693 p.a. (see also under "Salary"). (3 positions).
Qualifications: Degree in Agricultural Science, preferably with major in Agronomy. (Students graduating this year may apply.)
Duties: Experimental work in agronomy.

AGRICULTURAL OFFICER, Grade 1, £1,153-£1,693 p.a. (see also under "Salary"). (4 positions.)
Qualifications: (a) Degree in Agricultural Science (students graduating this year may apply); or (b) Diploma approved Agricultural College plus suitable experience, preferably in tropics.
Duties: General extension duties, maintain district agricultural stations, technical duties for specialist divisions, supervise special projects.

ASSISTANT AGRICULTURAL OFFICER, £687-£1,333 p.a. (see also under "Salary"). (12 positions.)
Qualifications: Diploma approved Agricultural College (students graduating this year may apply).
Duties: Extension duties, supervise special projects, technical duties for specialist divisions.

ANALYST, £1,153-£1,693 p.a. (male); £986-£1,436 (female). (See also under "Salary".)
Qualifications: Appropriate Degree of University of Technology or Technical College Diploma; sound knowledge analytical chemistry; experience soil and plant analysis desirable.
Duties: Manage chemical laboratory and conduct analyses.
Location: Port Moresby.

GENERAL INFORMATION

Salary: Rates quoted are actual for unmarried appointees and include allowances and adjustments. Additional Territorial Allowance is paid as follows:—

	Unmarried Male & Female	Married Male
	p.a.	p.a.
Less than 5 years' service	—	£125
5 years' service, but less than 7	£25	£150
7 years' service and over	£50	£175

Commencing rates for Assistant Agricultural Officers are:—

	Unmarried Male	Married Male
	p.a.	p.a.
At 18 years	£687	
At 19 years	£806	£1,095
At 20 years	£925	
At 21 years	£995	£1,098
At 22 years	£1,018	£1,143
At 23 years	£1,063	£1,188

but, irrespective of age, appointees with three years' suitable experience in Territory or four years elsewhere may receive a commencing salary of £1,153 (unmarried).

Appointees as Plant Pathologist, Soils Survey Officer, Agronomist, Agricultural Offier and Analyst receive commencing salaries, within ranges quoted, according to qualifications and experience.

Eligibility: Adult male British subjects under 45 years, except where otherwise stated. Minors 18 years and over may apply for Grade 1 and Assistant Agricultural Officer positions. Adult single females under 40 years may apply for Analyst.

Appointment: Permanent, subject to satisfactory probationary period.

Location: Appointees are required to serve anywhere in Territory. Where location is stated it refers to headquarters or initial posting only.

Accommodation: Single accommodation only available. Married accommodation not available under 18 months.

Separation Allowance: Payable at discretion of Territory Administration; designed to compensate for added expense of married appointees obliged to maintain family ouside Territory.

Leave: Three months after each 21 months in Territory. Additional three months' leave after each six years' service and six months' furlough at 20 years' service.

Taxation: Income derived by residents of Territory from sources within Territory is not at present taxable under Commonwealth legislation.

Further Information: An information handbook on the Public Service of the Territory is available from the Department of Territories, Canberra or Sydney, or from any Commonwealth Public Service Inspector, Commonwealth Employment Office, or official country Post Office. Other enquiries to Department of Territories, Canberra ('phone U 0411, ext. 29A).

Applications: Submit on prescribed form available from offices mentioned under "Further Information".
To—The Secretary, Department of Territories, Canberra, by 2nd November, 1957.

APPOINTMENTS AVAILABLE

COMMONWEALTH OF AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
DIVISION OF ANIMAL HEALTH AND PRODUCTION
APPOINTMENT OF DIVISIONAL SECRETARY

Applications are invited for appointment to a position of Divisional Secretary with the Organization's Division of Animal Health and Production, located at the McMaster Animal Health Laboratory in the grounds of the University of Sydney, where new accommodation for the headquarters of the Division has been provided.

The appointee will be required to assist the Chief of the Division in all matters relating to the organization of the research programme, the preparation of research reports and publications, and in dealing with associated enquiries and correspondence. He will also be required to become thoroughly familiar with the general administration of the Division as regards staff, estimates and facilities but such work will not be a major part of his responsibilities.

Applicants should possess a University degree in Agricultural or Veterinary Science with a broad knowledge of Australian animal health and production problems and post-graduate experience in research and its organization. Ability to express facts and opinions clearly and concisely is essential.

Commencing salary is dependent upon the appointee's qualifications and experience and will be determined within the salary range of £2,103-£2,323 p.a.

The appointment will be conditional on a satisfactory medical examination and the successful applicant will be asked to serve for an initial probationary period of up to twelve months before being confirmed in his appointment as an officer of the Organization. If so confirmed he will be required to contribute to and be eligible to receive benefits from either the Commonwealth Superannuation Fund or the Commonwealth Provident Account.

Applications quoting reference number 202/125 and stating full name, place, date and year of birth, marital state, nationality, present employment, particulars of qualifications and experience, and of war service, if any, accompanied by copies of not more than four testimonials, should reach the Chief, Division of Animal Health and Production, C.S.I.R.O., McMaster Laboratory, Parramatta Road, Glebe, New South Wales, by 14th October, 1957.

THE UNIVERSITY OF NEW ENGLAND

FACULTY OF RURAL SCIENCE

Applications are invited for the position of Lecturer in Poultry Science in the Faculty of Rural Science.

The salary range for Lecturers is £A1200 x £A80-£A1,750. In addition, a cost of living allowance of at present £A65 (males) or £A49 (females) is payable.

Provision is made for superannuation, travel and removal expenses, assistance in buying or building a home.

Further information and the conditions of appointment may be obtained from the undersigned with whom applications will close on 13th September, 1957.

T. C. LAMBLE,
Acting Registrar

Armidale, N.S.W.

PROCEEDINGS
of the
AUSTRALIAN SOCIETY OF ANIMAL PRODUCTION

VOL. 1

Reporting the 28 papers delivered at the Society's First Biennial Conference, Armidale, N.S.W., January, 1956, are available from—

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